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Nutrients required per Unit Of Product by Dairy Cows

Dairy Husbandry

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NUTRIENTS REQUIRED PER UNIT OF PRODUCT BY DAIRY COWS

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BY

CASSIUS CLAY HAYDEN

B. S. (Agr.) Ohio State University, 1901

THESIS

Submitted in Partial Fulfillment of the Requirements for the

Degree of

MASTER OF SCIENCE

IN DAIRY HUSBANDRY

IN

THE GRADUATE SCHOOL

OF THE

UNIVERSITY OF ILLINOIS

1909

1909
H32

UNIVERSITY OF ILLINOIS

THE GRADUATE SCHOOL

May 26, 1909

I HEREBY RECOMMEND THAT THE THESIS PREPARED UNDER MY SUPERVISION BY

Cassius Clay Hayden

ENTITLED Nutrients Required per Unit of Product by Dairy Cows.

BE ACCEPTED AS FULFILLING THIS PART OF THE REQUIREMENTS FOR THE

DEGREE OF Master of Science (in Dairy Husbandry).

W. J. Fraser
In Charge of Major Work

W. J. Fraser
Head of Department

Recommendation concurred in:

Committee
on
Final Examination

149328

INTRODUCTION.

During the past thirty years great progress has been made in the dairy industry. This has been brought about, in the main, by three things:--the invention of better machinery for handling and manufacturing the various dairy products; the improvement by breeding of cattle used for this purpose; and by the use of more rational methods of feeding. Certainly not the least of these is the question of feeding.

A few years ago the average dairyman fed his cattle the foods most easily obtained, and with little or no regard to the composition of such foods or to the needs of the animal. This condition still prevails on many of our dairy farms, but the knowledge necessary for intelligent feeding is gradually spreading through the medium of the farm papers, farmers' institutes, experiment station bulletins, and the various extension movements.

Without the knowledge which enables us to feed in a way which will require the animal to handle the minimum of waste materials, such records as those made by Jacoba Irene (Jersey) and Colantha 4th's Johanna (Holstein) would be practically impossible. The former produced in 365 days 17,253 pounds of milk containing 952 pounds of milk fat, and the latter 27,432 pounds of milk containing 998 pounds of milk fat.

While a great deal of work has been done and much has been written on the subject of feeding dairy cows, there is yet room for much careful investigation along this line. Authorities do not entirely agree on the standards used, and scientific findings are constantly changing former views.

OBJECT.

While the experiments from which the following data are taken were not conducted for this express purpose, data have been accumulated which may be

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brought to bear on the subject, especially from the practical standpoint. Our object is to compare this data with the standard commonly used and to bring out a few other points shown by the data.

No attempt will be made to review or discuss at length the literature on the subject. A simple statement of the steps thus far taken in feeding standards for dairy cows will be sufficient.

Brief Discussion of Standards.

In 1810 a comparison of foods was made by Thaer. The result was a feeding table in which was given the amount of various foods equivalent, in feeding value, to one hundred pounds of "Meadow Hay." Much difference of opinion on these values existed, but it led to more careful investigation on the subject.

The first feeding standard for farm animals in general was proposed by Grauven in 1859 and was based on the content of protein, carbohydrates and fat, shown by chemical analysis. He recommended that the dairy cow be given 2.74 pounds of protein. This was objected to on the ground that it considered only total nutrients and not digestible nutrients.

From this time on, some of our best scientists have been working on this important subject of animal nutrition and the result has been a great improvement in standards.

The first feeding standard based on digestible nutrients was published by Emil V. Wolff, the great German scientist, in 1864. His aim was to so balance these nutrients in the daily ration that the animal would not be required to handle an excess of one in order to get a sufficient quantity of the other. His standard for dairy cows was as follows: dry matter, 24 pounds; protein, 2.5 pounds; carbohydrates, 12.5 pounds; and ether extract, .4 pounds, a nutritive ratio of 1:5.4. This standard was a great improvement over previous standards and came into general use. It was severely criticised from different points of view. One of the criticisms was that it did not take into

account the different degrees of production by the animal.

About 1897 it was modified by Dr. C. Lehmann in such a manner as to take into account this variation in production to the following extent:

	Dry matter	Prot.	Carbo.	Fat.	N. R.
Cows giving 11 # milk,	25	1.6	10.0	.3	1:6.7
" " 16-1/2# "	27	2.0	11.0	.4	1:6.0
" " 22 # "	29	2.5	13.0	.5	1:5.7
" " 27-1/2# "	32	3.3	13.0	.8	1:4.5

Standards were introduced into this country largely through the efforts of Atwater, who proposed a standard as follows: dry matter, 25 pounds; protein, 2.5 pounds; carbohydrates, 12 to 13 pounds; and fat, .5 to .8 pounds, with a nutritive ratio of 1:5.6.

Professor F. W. Woll, of the University of Wisconsin, proposed a so-called "American Standard" which was as follows: dry matter, 24.5 pounds; protein, 2.15 pounds; carbohydrates, 13.27 pounds; and fat, .74 pounds, with a nutritive ratio of 1:6.9. This standard was arrived at by collecting from a large number of dairymen the rations fed their cows, and striking an average. Some of these rations would be interesting from a practical standpoint, but we shall neither take time nor space to introduce them here.

Kuehn suggested that a basal ration, consisting largely of roughage, be fed cows giving a small amount of milk, and increase the more nutritious foods as the production increases.

It should be remembered that all standards are based on a live weight of 1000 pounds. The Wolff-Lehmann standard called for .7 pound protein, 8. pounds carbohydrates, and .1 pound fat to maintain a 1000 pound animal without either gaining or losing in weight when kept at rest. This was found to be too high, and has been reduced to .7 pound protein, 7. pounds carbohydrates, and .1 pound fat for a 1000 dairy cow under normal conditions.

The latest important work done on this subject directly was by Professor T. L. Haecker, of the University of Minnesota. His work extends

over a number of years with a comparatively large number of cows. He has proposed a standard, based on his findings, which is lower in protein than former standards and which is supposed to be adapted to all degrees of production.

It is based on the fat content of the milk as well as the amount of milk produced. This is a step in advance of those based on the live weight and quantity of milk alone. Theoretically, a more perfect standard would be one based on the total milk solids produced, together with the live weight. The ordinary dairyman, however, is not able to make a determination of solids as readily as a determination of fat, and such a standard would make the compounding of rations more difficult for him.

Haecker's standard is the one now commonly used in our dairy schools, and is stated as follows in bulletin 79 of the Minnesota Experiment Station:

Coefficients for food of maintenance per cwt., and
nutrients required for the production of one pound
of milk testing a given per cent of butter fat.

	Protein	Carbo-hydrates	Ether Extract
For Maintenance	.07	.7	.01
Milk Testing 2.5	.0362	.164	.0124
" " 2.6	.0369	.167	.0126
" " 2.7	.0376	.171	.0129
" " 2.8	.0383	.174	.0131
" " 2.9	.0390	.178	.0134
" " 3.0	.0397	.181	.0136
" " 3.1	.0404	.185	.0139
" " 3.2	.0411	.188	.0141
" " 3.3	.0418	.192	.0144
" " 3.4	.0425	.195	.0146
" " 3.5	.0432	.199	.0149
" " 3.6	.0439	.202	.0151
" " 3.7	.0446	.206	.0154
" " 3.8	.0453	.209	.0156
" " 3.9	.0460	.213	.0159
" " 4.0	.0467	.216	.0161
" " 4.1	.0474	.220	.0164
" " 4.2	.0481	.223	.0166
" " 4.3	.0488	.227	.0169
" " 4.4	.0495	.230	.0171

	Protein	Carbohydrates	Ether Extract
Milk Testing 4.5	.0502	.234	.0174
" " 4.6	.0509	.237	.0176
" " 4.7	.0516	.241	.0179
" " 4.8	.0523	.244	.0181
" " 4.9	.0530	.248	.0184
" " 5.0	.0537	.251	.0186
" " 5.1	.0544	.255	.0189
" " 5.2	.0551	.258	.0191
" " 5.3	.0558	.262	.0194
" " 5.4	.0565	.265	.0196
" " 5.5	.0572	.269	.0199
" " 5.6	.0579	.272	.0201
" " 5.7	.0586	.276	.0204
" " 5.8	.0593	.279	.0206
" " 5.9	.0600	.283	.0209
" " 6.0	.0607	.286	.0211
" " 6.1	.0614	.290	.0214
" " 6.2	.0621	.293	.0216
" " 6.3	.0628	.297	.0219
" " 6.4	.0635	.300	.0221
" " 6.5	.0642	.304	.0224

It is with this standard that we propose to compare our findings in the following data.

Bibliography.

Feeds and Feeding. ---W. A. Henry.
Experiment Station Record, Vol. IV.
Minnesota bulletins, 71, 76, 79, 106.

PRESENTATION.

The data here presented was taken from a feeding experiment conducted with thirteen cows. The individual cows were in the experiment from one to four years. The relative time is shown in plate one. In all, thirty-five yearly records are presented. A summary from two other experiments including twenty-nine cows will be given.

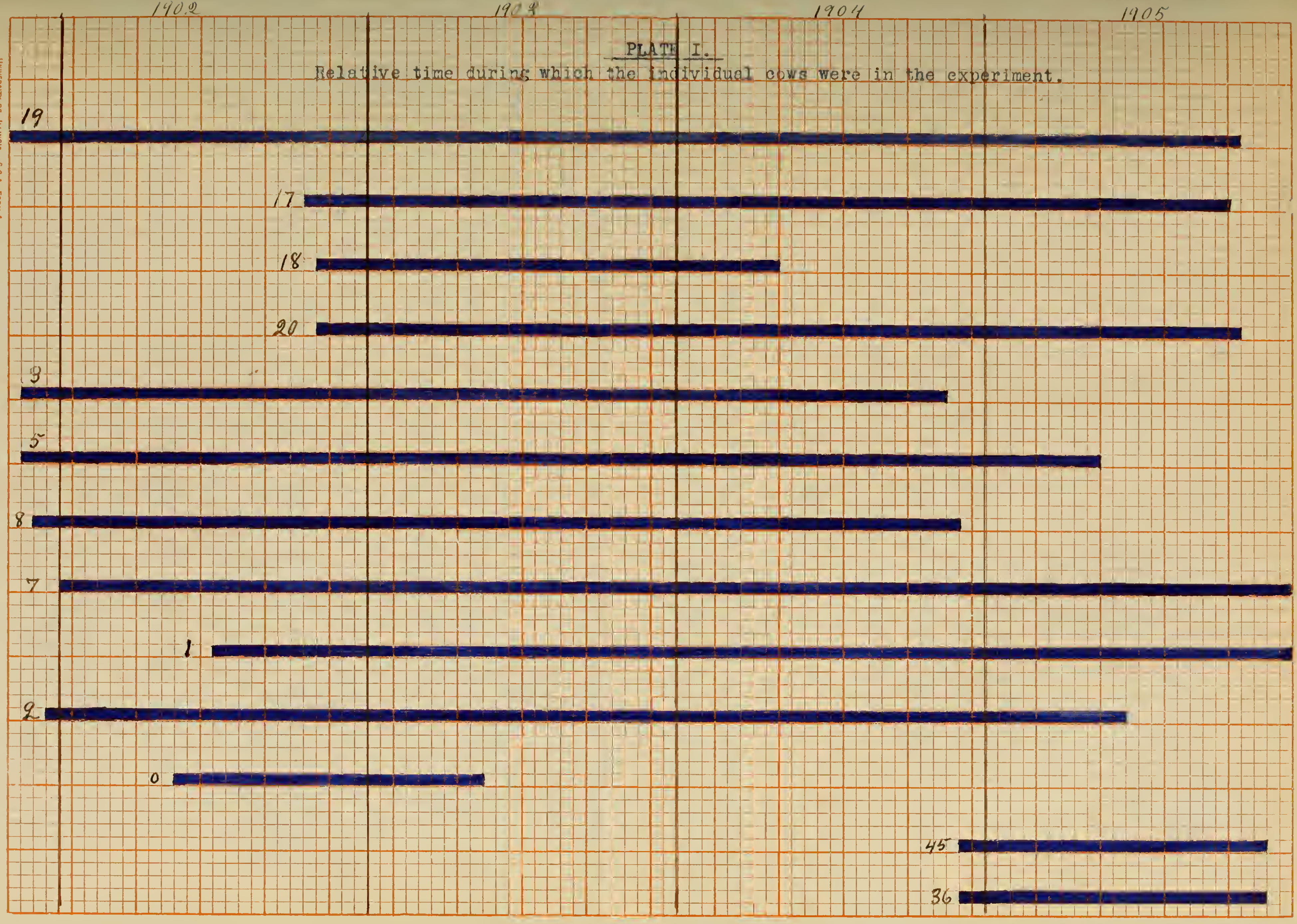
The cows used were by no means all of the best producing type. A part of them was selected from dairy herds in the Elgin district as typical good and poor dairy cows. Others were pure-bred animals taken from the University herd. They were perhaps about an average lot of cows and were kept as nearly as possible under like conditions.

Two rations were fed, as follows: the first consisted of silage made from well eared, well matured corn, alfalfa or clover hay, and a grain mixture consisting of bran 50 pounds, oats 25 pounds, Buffalo gluten feed 12-1/2 pounds, corn meal 10 pounds, and oil meal 2-1/2 pounds. This was fed to cows Herd Nos. 19, 3, 5, 7, 8, 17, 20, 2 and 0. The second ration consisted of the same roughage as above, and a grain mixture consisting of bran 120 pounds, corn meal 120 pounds, oats 60 pounds and oil meal 20 pounds. This ration was fed to cows 18, 45 and 36.

All feed was carefully weighed back, and the exact amount eaten recorded. They were liberally fed, and carried a good amount of flesh, though there was practically no gain in weight from the beginning to the end of the experiment. It is to be regretted, however, that some of the data which would give more weight to the conclusions is seriously lacking. For this reason it is very important that the reader keep in mind two things: careful analyses of the food consumed were not obtained; chemical analyses of the milk were not obtained for solids other than fat. Careful records were kept of the

PLATE I.

Relative time during which the individual cows were in the experiment.



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amount of milk and its content of fat.

The coefficients here used in calculating the digestible nutrients were taken from Henry's tables. The factors used for silage are undoubtedly too low. The silage was made from well eared corn, well matured, and undoubtedly contained a much higher percentage of dry matter than is given in Henry's tables.

The percentage of solids in the milk has in all cases been estimated, the estimate being based on the percentage of fat. See Plate II.

Wherever the term "Nutrients" appears in the following data or discussion, it implies *digestible nutrients* only, unless otherwise stated.

Part One.

In this part an attempt is made to show the varying amounts of nutrients required per unit of product, from the beginning to the close of the lactation period, or up to one year from calving. An average for the entire time is given, and this average is compared with the existing standard.

In the following tables, the upper number above the line at the top of the column is the herd number of the cow, and the one immediately beneath shows the number of lactation periods from which the average was taken.

Table one shows the average amount of milk produced per week by the individual cows. It gives a good idea of the productive capacity of the cows used in this experiment, the average at the beginning of the period being about 34 pounds of milk, testing 3.7% fat, per day, and about 7 pounds of milk, testing 6% fat, per day at the close. Note that some of them were not persistent milkers and in neither period, out of three or four, continued for one year. This was true of numbers 20, 3, 5 and 7.

Table two is made up in the same manner as table one, and shows the average fat produced by the individual cows.

Table three shows the average amount of protein consumed per cow per week during the lactation period, which is the same period covered by tables

TABLE NO. 1.

Average Lbs. of Milk Produced per Cow per Week During Lactation Period.

No. Cow	19	17	18	20	3	5	8	7	1	2	0	45	36
No. P'ds	3-1/2	3	1	3	4	3	2-1/2	4	3	3	3	1	1
Week 1	51.0	227.5	307.9	107.1	168.2	140.7	164.6	181.0	126.4	189.1	154.5	---.-	195.5
" 2	109.6	281.3	319.5	197.0	236.8	232.1	162.0	241.2	294.2	244.9	242.4	---.-	267.1
" 3	162.7	344.8	319.2	198.4	232.4	243.6	166.0	236.9	308.4	250.7	233.7	---.-	235.1
" 4	164.2	351.5	291.3	190.6	214.7	244.2	166.2	230.0	310.6	274.6	222.3	251.3	243.7
" 5	161.3	335.5	274.9	186.8	212.6	214.9	165.6	226.8	312.3	266.2	236.9	242.2	248.8
" 6	156.2	331.0	258.1	194.8	191.8	253.1	166.7	222.2	315.7	263.5	140.5	228.4	240.5
" 7	152.2	327.1	262.1	175.5	170.3	245.9	164.7	210.8	323.2	238.8	131.5	219.8	205.0
" 8	151.2	302.5	274.3	180.2	168.7	249.2	159.0	205.7	310.5	245.5	187.2	207.8	237.9
" 9	139.6	290.2	279.2	176.5	167.4	239.8	156.5	197.2	305.8	245.8	181.1	205.4	217.1
" 10	132.5	290.1	255.6	169.5	158.5	233.4	149.4	192.3	296.6	240.6	177.0	189.3	231.7
" 11	131.0	289.8	259.0	161.9	153.2	218.7	144.9	186.8	294.7	243.5	181.9	184.4	240.6
" 12	130.8	282.2	239.4	155.7	131.1	212.5	134.5	166.9	197.2	226.9	196.6	174.3	245.2
" 13	129.7	275.0	155.1	149.9	136.1	215.8	137.4	166.5	285.1	225.7	155.1	172.9	229.2
" 14	121.4	283.2	183.4	149.6	128.3	203.6	135.4	165.6	273.9	228.1	152.0	174.2	203.6
" 15	125.8	279.2	189.1	148.0	114.2	196.8	138.8	159.5	291.3	223.8	151.2	185.2	240.0
" 16	119.9	278.4	192.6	149.2	122.9	186.0	123.8	148.8	297.3	215.8	155.9	187.9	235.6
" 17	113.4	275.5	188.6	147.4	112.4	174.5	116.8	149.5	302.3	203.7	147.4	196.0	232.6
" 18	111.2	285.9	186.4	142.6	108.7	171.8	112.3	140.8	291.0	196.7	144.6	187.1	229.2
" 19	109.0	272.2	198.2	141.6	103.1	174.8	112.4	139.6	302.8	187.4	130.1	191.9	211.7
" 20	107.1	260.5	196.1	142.0	98.5	174.2	105.2	133.6	306.2	190.8	131.4	188.4	207.9
" 21	107.0	250.3	182.6	138.7	92.5	172.4	102.0	123.3	309.9	199.4	132.8	183.0	215.9
" 22	103.0	255.2	184.9	136.2	86.8	173.1	106.4	113.9	304.2	182.0	112.8	184.6	223.5
" 23	101.8	248.8	181.7	131.8	84.7	162.1	106.3	115.1	293.8	169.8	123.7	183.2	210.8
" 24	101.3	230.1	182.4	131.6	77.8	163.1	110.3	112.6	298.1	151.1	119.3	174.9	199.6
" 25	102.4	234.2	166.6	131.9	88.2	157.9	107.3	112.9	299.6	165.7	121.1	181.7	232.5
" 26	106.3	223.5	164.6	133.3	90.4	146.3	109.2	105.8	289.9	166.5	135.5	174.5	220.4

TABLE NO. 1.. (Continued)

Average Lbs. of Milk Produced per Cow per Week During Lactation Period.

No. Cow	19	17	18	20	3	5	8	7	1	2	0	45	36
No. P'ds	3-1/2	3	1	3	4	3	2-1/2	4	3	3	3	1	1
Week 27	96.3	214.6	180.7	136.3	74.6	119.9	114.0	101.3	281.3	126.8	50.7	159.1	199.1
" 28	98.7	216.0	179.0	121.7	78.3	141.5	90.2	92.9	284.4	121.3	122.8	147.5	218.7
" 29	85.1	212.2	173.2	121.2	68.3	113.5	74.8	83.3	278.6	147.4	123.5	163.8	198.3
" 30	85.4	211.2	165.8	119.1	61.1	94.2	79.0	96.3	271.1	143.0	110.1	156.1	201.3
" 31	87.5	197.9	164.6	111.2	60.5	84.3	71.1	88.8	263.9	140.3	121.5	140.6	199.9
" 32	88.7	195.9	163.7	108.5	55.4	86.1	76.2	78.2	246.1	136.3	115.5	130.9	206.5
" 33	79.6	173.8	182.4	101.1	55.1	83.4	69.3	68.5	235.2	148.2	112.0	141.3	203.4
" 34	80.4	170.5	140.7	97.3	56.5	87.5	122.5	64.1	217.1	139.2	113.6	138.6	192.1
" 35	76.5	155.0	142.6	96.6	50.9	92.6	112.1	57.7	291.9	130.6	109.6	123.5	187.9
" 36	74.8	156.7	124.1	92.9	51.3	78.5	133.3	55.4	211.6	132.8	106.9	109.5	183.9
" 37	78.0	154.6	111.0	86.2	46.3	74.0	129.8	75.0	199.0	134.3	109.7	129.5	173.9
" 38	78.9	149.7	112.5	80.8	45.8	68.5	77.0	69.7	189.5	131.8	110.6	117.6	181.0
" 39	77.1	137.6	113.7	81.1	39.7	65.3	97.2	61.1	166.9	127.1	106.0	100.2	179.2
" 40	72.2	122.0	94.0	84.2	38.1	57.5	92.4	44.6	147.6	132.5	106.2	95.2	174.8
" 41	67.7	104.7	102.7	80.4	45.2	70.2	94.6	25.0	123.6	132.9	102.9	114.5	181.4
" 42	48.6	88.9	110.7	72.8	51.4	71.4	86.9	21.7	123.1	125.7	99.1	95.7	176.3
" 43	71.4	90.8	101.7	61.9	45.5	73.0	99.3	--.-	115.2	111.7	105.3	86.3	171.3
" 44	58.1	72.7	79.6	50.1	43.6	72.9	98.5	--.-	78.2	103.3	103.5	97.8	156.0
" 45	54.1	51.6	60.2	14.7	40.1	63.6	96.4	--.-	32.4	99.3	100.9	116.0	151.9
" 46	56.9	70.2	44.1	3.7	30.7	55.9	91.5	--.-	113.5	96.3	99.6	100.1	148.5
" 47	51.0	59.0	39.6	--.-	35.3	40.8	93.9	--.-	121.1	86.9	99.0	83.3	131.5
" 48	66.5	43.5	32.8	--.-	27.5	23.4	93.6	--.-	110.1	81.4	108.1	103.7	135.2
" 49	63.5	32.5	28.7	--.-	8.5	15.8	97.5	--.-	94.8	69.7	102.6	120.4	142.7
" 50	60.9	25.8	21.1	--.-	--.-	--.-	92.8	--.-	84.9	61.5	100.0	107.4	137.4
" 51	58.9	23.7	12.6	--.-	--.-	--.-	93.4	--.-	84.3	77.1	101.1	89.5	119.1
" 52	--.-	18.1	--.-	--.-	--.-	--.-	89.5	--.-	53.0	54.6	97.0	106.0	108.1

TABLE NO. 2.

Average Amount of Fat Produced per Cow per Week During Lactation Period.

No. Cow	19	17	18	20	3	5	8	7	1	2	0	45	36
No. P'ds	3-1/2	3	1	3	4	3	2-1/2	4	3	3	1	1	1
Week 1	2.31	9.86	7.16	6.91	6.54	4.82	6.59	6.53	4.37	7.03	6.49	-.--	6.45
" 2	5.58	11.52	10.86	10.01	8.99	8.72	6.50	8.93	9.84	7.68	10.66	-.--	8.55
" 3	5.64	11.93	10.85	10.44	8.43	9.15	6.30	9.12	12.13	7.88	9.81	-.--	7.76
" 4	5.91	11.01	10.49	9.45	7.61	9.69	6.14	9.05	11.12	8.15	9.34	12.82	7.55
" 5	5.68	11.05	8.81	9.16	7.64	8.88	6.52	9.25	11.84	8.59	5.75	11.14	7.81
" 6	5.66	10.66	8.00	9.03	6.81	10.61	6.67	9.47	11.93	8.85	6.18	10.96	7.70
" 7	5.32	9.67	8.11	9.16	6.21	9.45	6.31	8.60	12.27	7.75	6.83	10.55	5.74
" 8	5.25	9.33	8.23	9.12	6.13	9.69	6.57	7.98	10.00	6.96	10.11	9.56	7.14
" 9	4.88	9.11	8.38	9.06	5.61	9.31	6.46	7.60	10.55	7.70	7.97	9.65	5.86
" 10	4.72	8.73	7.92	8.38	5.54	9.44	6.22	7.49	9.86	7.60	7.43	9.69	6.95
" 11	4.29	8.62	7.77	8.11	5.66	8.51	6.10	7.24	10.30	8.20	8.19	9.04	10.83
" 12	4.41	9.22	7.42	8.14	4.28	8.04	5.64	6.63	9.98	7.49	8.06	9.41	7.36
" 13	4.19	8.42	5.12	7.62	4.34	8.58	5.62	6.60	9.97	7.30	7.13	9.65	6.88
" 14	4.21	8.56	5.87	7.58	4.42	8.12	5.64	6.51	9.69	8.07	6.69	9.06	5.70
" 15	4.28	8.24	6.29	7.59	3.78	7.31	5.82	6.47	10.27	7.42	7.11	8.89	7.44
" 16	3.91	7.95	6.16	7.39	4.50	6.75	5.20	5.82	11.02	7.35	7.33	9.02	7.30
" 17	3.81	7.93	5.66	7.49	3.80	6.57	4.82	5.97	10.94	6.95	6.63	9.02	7.21
" 18	3.84	8.16	5.59	7.06	3.71	6.52	4.66	5.48	10.73	6.81	7.81	9.36	6.88
" 19	3.51	7.65	6.34	7.05	3.55	6.48	4.63	5.30	10.51	6.48	6.76	9.40	6.56
" 20	3.59	7.83	5.88	7.47	3.38	6.55	4.06	5.30	10.51	6.44	7.75	8.10	6.65
" 21	3.81	7.85	5.48	7.04	3.19	6.50	4.20	5.08	10.84	6.33	8.20	8.60	7.12
" 22	3.45	7.52	5.73	6.85	3.03	6.51	4.45	4.60	10.23	6.01	7.22	8.49	6.71
" 23	3.40	7.28	5.63	6.71	3.22	6.14	4.76	4.81	10.52	5.65	7.42	8.61	6.75
" 24	3.81	7.37	5.11	6.46	2.98	6.70	4.81	4.85	10.46	5.27	6.44	8.40	7.18
" 25	3.34	6.76	4.83	6.39	2.90	6.69	4.16	4.64	10.64	5.44	6.39	8.36	6.98
" 26	3.52	6.01	4.94	6.36	3.33	5.91	4.66	4.31	10.39	4.45	7.45	7.85	7.27

TABLE NO. 2 . (C0ntinued)

Average Amount of Fat Produced per Cow per Week During Lactation Period.

No. Cow No. P'ds	19 3-1/2	17 3	18 1	20 3	3 4	5 3	8 2-1/2	7 4	1 3	2 3	0 1	45 1	36 1
Week 27	3.27	5.96	5.60	6.40	3.13	4.76	4.89	4.12	9.90	4.58	2.94	7.32	6.37
" 28	3.31	6.39	5.19	5.76	2.63	5.33	3.54	4.12	9.93	4.48	7.49	6.49	7.22
" 29	2.81	6.46	5.54	5.39	2.83	4.39	3.24	4.15	9.97	5.28	7.29	7.85	6.35
" 30	2.96	6.21	5.47	5.44	1.96	3.88	3.36	4.18	9.76	5.20	6.60	7.18	6.64
" 31	3.03	6.02	5.59	4.71	2.09	3.44	3.11	3.71	9.51	5.12	7.22	6.48	5.20
" 32	3.06	5.67	4.58	5.17	2.18	3.30	3.24	3.61	8.38	4.97	6.81	5.50	6.40
" 33	2.65	5.47	4.19	4.98	1.93	3.31	2.89	3.17	8.76	4.88	6.72	7.07	5.90
" 34	2.73	5.06	4.08	4.59	2.04	3.63	5.36	2.67	8.29	4.84	6.36	6.10	5.76
" 35	2.69	4.61	4.42	5.06	2.09	3.79	5.40	2.36	6.97	4.65	6.90	4.20	5.64
" 36	2.65	4.93	3.72	4.66	1.76	3.24	5.33	2.45	7.77	4.70	6.52	3.72	5.52
" 37	2.63	4.97	3.66	3.99	1.78	2.80	5.19	2.31	7.48	4.63	6.69	5.44	5.56
" 38	2.58	4.76	3.49	4.11	1.65	2.39	3.00	3.01	7.06	4.48	6.52	5.41	5.79
" 39	2.56	4.53	3.41	3.98	1.61	2.39	3.89	2.31	6.42	4.57	6.57	3.91	5.38
" 40	2.41	3.74	2.91	4.54	1.25	2.05	3.74	1.93	5.68	4.97	5.96	4.86	5.24
" 41	2.12	3.03	3.31	4.27	1.28	2.69	3.88	.86	4.50	5.17	6.28	5.61	5.80
" 42	2.13	2.96	2.95	4.04	1.43	2.30	4.00	.91	4.35	4.76	6.40	3.73	5.64
" 43	2.35	2.73	2.63	3.56	1.80	2.76	4.17	-.--	4.53	4.43	7.26	3.80	5.82
" 44	1.50	1.33	2.17	2.84	1.60	2.63	4.73	-.--	2.97	4.19	6.21	4.40	5.77
" 45	1.83	1.96	1.46	1.43	1.59	2.48	4.43	-.--	1.99	4.68	5.55	5.22	6.99
" 46	1.75	3.16	1.39	.73	1.40	2.15	4.39	-.--	4.77	3.82	5.58	4.80	5.94
" 47	1.72	1.74	1.15	-.--	1.85	.94	3.94	-.--	4.48	3.41	5.71	4.41	5.62
" 48	2.20	1.43	.94	-.--	1.77	.87	3.74	-.--	4.40	3.17	5.62	5.29	5.14
" 49	1.49	.98	.72	-.--	1.32	.50	3.90	-.--	3.79	2.85	5.85	6.38	5.71
" 50	2.06	.97	.37	-.--	.30	.22	3.71	-.--	3.57	3.14	5.50	6.01	4.95
" 51	2.02	.72	.04	-.--	-.--	-.--	3.83	-.--	3.37	3.05	5.96	5.01	4.76
" 52	1.98	.36	-.--	-.--	-.--	-.--	4.30	-.--	2.17	2.50	5.43	5.40	4.43

TABLE NO. 3.

Average Lbs. Protein Consumed per Cow per Week During Lactation Periods.

No. Cow		19	17	18	20	3	5	8	7	1	2	0	45	36
No. P'ds		3-1/2	3	1	3	4	3	2-1/2	4	3	3	1	1	1
Week	1	8.23	13.95	11.79	10.31	9.32	11.56	8.82	9.87	13.92	10.11	4.55	--.--	17.84
"	2	13.24	18.25	18.51	11.83	11.96	13.32	9.29	12.66	19.98	11.87	11.10	--.--	14.72
"	3	13.87	20.28	19.72	12.30	12.77	14.63	13.15	13.97	21.32	12.92	12.50	--.--	13.79
"	4	14.72	20.63	18.67	11.70	13.64	15.37	17.02	14.49	22.93	11.98	12.38	14.25	14.47
"	5	15.39	19.83	17.64	11.99	13.87	15.91	16.33	14.88	23.06	15.70	11.18	12.50	10.56
"	6	14.97	10.70	17.49	12.98	13.85	14.51	16.15	15.48	18.93	15.00	11.19	12.00	13.90
"	7	14.70	18.83	17.26	12.67	12.20	14.75	15.32	14.44	18.21	14.52	11.19	14.37	14.92
"	8	14.04	17.79	17.03	13.08	13.15	15.58	15.59	13.59	18.82	15.49	11.19	10.65	18.75
"	9	13.60	16.41	16.85	12.93	12.83	15.19	15.19	14.16	18.08	18.83	14.99	13.86	16.91
"	10	12.61	17.50	21.63	13.42	12.30	14.62	15.29	14.38	19.20	19.32	20.02	13.29	19.40
"	11	13.69	19.05	17.41	13.39	11.60	15.01	14.60	14.12	18.62	18.87	11.86	14.74	19.58
"	12	15.02	17.02	17.00	13.38	10.07	15.80	15.80	13.96	19.07	16.65	11.84	13.35	19.98
"	13	14.48	16.73	8.85	13.34	11.58	18.88	16.06	13.79	18.88	16.63	12.78	14.17	17.61
"	14	15.39	16.78	9.92	13.62	11.32	19.19	17.43	16.06	15.92	16.48	12.86	14.71	14.55
"	15	18.05	17.81	11.34	13.03	12.90	18.08	17.36	16.03	20.11	16.51	13.56	18.35	19.72
"	16	17.71	17.82	12.72	12.93	11.55	15.75	15.62	16.75	20.24	16.19	13.88	18.02	20.54
"	17	18.56	18.75	14.34	13.89	12.31	16.12	16.60	17.44	20.20	17.06	14.05	18.55	19.17
"	18	15.01	19.36	13.45	13.67	13.01	16.29	15.86	16.47	20.64	17.82	15.00	18.82	17.29
"	19	15.26	19.19	13.45	12.93	12.60	21.57	15.85	16.85	20.83	17.14	12.00	18.03	17.96
"	20	15.22	18.17	13.46	12.73	14.44	16.69	14.62	16.06	20.68	20.35	13.94	15.96	18.18
"	21	16.37	16.63	13.45	12.86	16.94	16.97	10.56	15.26	22.52	19.72	13.93	15.96	16.20
"	22	15.49	16.51	13.56	12.43	14.08	17.08	11.36	16.17	22.77	19.43	11.16	14.53	17.53
"	23	15.40	16.63	12.88	12.46	14.83	16.98	12.79	17.16	22.32	17.74	13.82	14.75	17.11
"	24	16.07	16.29	12.58	12.43	13.88	20.27	10.55	16.98	20.30	17.79	14.40	13.32	15.24
"	25	16.24	16.23	12.60	12.39	15.24	19.75	11.05	17.47	19.42	18.28	14.40	13.42	16.12
"	26	19.42	15.91	12.58	12.58	13.22	19.11	11.19	16.82	20.04	18.08	14.15	13.71	17.06

TABLE NO. 3. (Continued)

Average Lbs. Protein Consumed per Cow per Week During Lactation Periods.

No. Cow	19	17	18	20	3	5	8	7	1	2	0	45	36
No. P'ds	3-1/2	3	1	3	4	3	2-1/2	4	3	3	1	1	1
Week 27	10.43	15.46	10.78	13.09	12.56	19.71	11.03	17.18	20.08	18.13	12.86	11.98	16.12
" 28	14.40	19.07	12.58	12.51	12.17	17.02	10.67	17.54	18.87	18.16	12.70	12.41	16.12
" 29	13.65	19.90	12.58	13.57	12.06	17.43	10.03	15.74	20.58	17.52	12.50	14.16	16.12
" 30	12.71	18.33	12.58	14.55	13.90	17.11	10.10	14.72	18.90	18.20	12.55	15.35	16.12
" 31	12.44	19.71	12.58	13.91	13.22	17.27	9.85	15.49	18.12	18.66	13.19	13.85	16.31
" 32	15.12	19.58	10.82	15.15	12.88	16.38	9.27	15.43	17.65	13.29	11.26	14.10	17.66
" 33	15.13	15.78	11.35	12.99	12.83	17.58	11.18	14.98	17.39	12.94	11.69	14.94	17.00
" 34	15.61	19.18	11.89	13.23	12.50	15.28	20.71	14.64	16.68	11.70	14.97	15.19	15.76
" 35	15.47	20.91	12.47	13.09	11.75	16.85	10.32	12.66	17.20	12.33	10.92	16.02	15.74
" 36	14.42	20.74	11.31	13.33	10.40	11.89	11.09	11.91	17.40	11.87	10.14	15.63	14.42
" 37	14.13	19.42	16.26	14.40	10.61	11.63	11.42	11.71	17.16	12.72	10.41	14.59	15.74
" 38	12.92	19.53	23.20	16.01	10.05	11.02	11.37	12.06	17.05	12.57	10.23	13.25	15.52
" 39	10.49	22.76	15.25	15.56	10.23	11.28	10.76	11.77	19.54	13.16	9.80	13.23	15.74
" 40	11.32	21.48	15.30	16.15	9.73	11.05	10.82	12.55	16.09	13.70	10.11	14.09	20.27
" 41	11.96	21.12	15.32	19.60	9.02	10.07	10.38	12.03	13.52	13.95	10.92	14.42	20.12
" 42	11.58	19.99	16.51	17.72	10.07	11.44	12.31	13.92	15.13	13.75	9.97	17.80	20.52
" 43	11.56	19.91	14.87	13.92	7.31	12.37	12.99	--.--	13.77	12.89	9.97	15.67	20.57
" 44	10.61	16.26	15.11	13.22	10.36	13.22	12.77	--.--	11.01	13.18	9.97	29.53	20.62
" 45	10.56	16.60	14.14	10.60	8.99	13.23	12.56	--.--	3.39	13.02	9.97	19.48	20.42
" 46	11.82	14.42	13.63	12.00	13.03	13.49	12.07	--.--	12.62	13.05	10.44	14.88	26.74
" 47	11.15	15.37	14.44	--.--	12.54	12.64	12.77	--.--	12.92	13.19	10.44	19,29	26.31
" 48	10.81	15.06	14.58	--.--	13.09	12.45	13.01	--.--	12.89	13.45	10.03	22.13	21.44
" 49	13.69	12.47	12.99	--.--	13.16	11.93	12.99	--.--	9.80	12.14	10.72	15.99	18.09
" 50	14,01	10.20	14.58	--.--	--.--	7.29	12.12	--.--	9.98	10.01	10.44	14.91	17.28
" 51	13.80	11.10	13.59	--.--	--.--	--.--	12.50	--.--	9.40	13.20	8.95	14.05	17.28
" 52	--.--	11.10	--.--	--.--	--.--	--.--	11.68	--.--	--.--	11.25	10.45	14.09	17.20

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one and two. The important thing shown in this table is that in many cases the amount of protein consumed did not decrease, as the period advanced, in proportion to the decrease in milk flow, which, theoretically, it should have done. This was due, to some extent, to the character of the roughage available, especially the liberal feeding of alfalfa hay toward the latter part of the period. The amount consumed per day ranges from 1.3 pounds to 3 pounds.

Table four shows the average amount of carbohydrates consumed per cow per week during the same period. The amount consumed per cow per day ranges from about 8 pounds to about 15 pounds.

Table five shows the average amount of fat consumed per cow per week during the same time covered by the foregoing tables. The amount consumed per cow per day ranges from .7 pounds to .97 pounds.

Table six is the average taken from the preceeding tables and shows the average amount of milk and fat produced and the average amount of nutrients consumed per week by the 13 cows during 33 lactation periods.

There is a gradual decrease in the milk flow after the fourth week. This decrease in milk is not accompanied by a material increase in the percentage of fat until the last third of the period is reached. During this last third there is an increase from 3.7 per cent fat to 6 per cent fat, an increase of 2.3 per cent. In this table the food fat was multiplied by 2-1/4 to reduce it to the same basis as the carbohydrates, for the purpose of getting the total nutrients on the same basis.

Table seven was constructed from table six, and shows the average amount per unit of product in the form of milk solids. The milk solids are the true measure of production. We do not now make up our rations based on the amount of milk alone, but take into consideration the per cent of fat, as well. It would be still better to base them on the milk solids, but these are not so easily determined, and therefore not altogether practical for the common farmer.

TABLE NO. 4.

Average No. Lbs. Carbohydrates Consumed per Cow per Week During Lactation Period.

No. Cow	19	17	18	20	3	5	8	7	1	2	0	45	36
No. P'ds	3-1/2	3	1	3	4	3	2-1/2	4	3	3	1	1	1
Week 1	49.17	70.75	63.33	53.27	56.40	62.04	52.98	58.93	59.27	59.22	24.95	--.--	96.02
" 2	66.76	92.76	95.93	62.00	65.46	75.56	53.45	70.32	90.95	68.22	61.37	--.--	82.73
" 3	72.05	96.25	102.98	64.65	70.48	82.08	66.49	74.19	92.36	70.12	69.12	--.--	76.39
" 4	78.46	98.93	95.98	59.99	72.38	83.71	76.28	76.66	100.90	81.27	68.49	78.32	78.55
" 5	57.50	102.14	87.91	60.34	73.07	85.89	72.37	78.10	108.64	83.72	61.82	71.23	59.57
" 6	76.68	102.77	86.53	65.09	71.51	79.45	70.18	79.05	92.95	79.81	61.81	68.20	79.84
" 7	76.15	96.33	83.71	63.98	67.69	79.49	74.75	72.77	92.31	75.50	61.81	77.20	76.16
" 8	71.50	96.11	81.77	65.31	68.27	83.30	75.93	69.28	91.22	78.81	61.81	59.01	95.15
" 9	61.13	92.91	80.66	65.37	65.67	81.83	70.55	72.13	91.77	85.89	81.86	79.67	87.20
" 10	72.19	89.60	103.85	70.00	62.33	78.36	60.69	73.08	96.22	87.56	109.09	57.98	98.55
" 11	74.65	91.77	85.57	66.36	57.56	79.05	69.88	71.07	93.23	87.05	74.04	81.58	98.91
" 12	73.43	89.85	83.74	67.06	50.28	83,59	67.26	71.99	92,79	82.52	67.44	76.77	96.91
" 13	76.76	87.69	46.26	67.98	54.41	86.36	73.89	68.48	91.56	82.43	79.30	81.66	86.68
" 14	79.68	86.46	57.16	68.61	53.78	88.26	75.24	72.52	79.02	82.91	79.76	81.66	74.97
" 15	78.54	86.81	62.69	67.03	56.20	82.73	74.35	73.46	97.43	81.70	83.58	97.97	97.65
" 16	81.56	92.20	67.93	68.33	63.73	78.77	74.48	75.07	99.49	79.97	81.09	97.13	101.65
" 17	68.96	91.35	75.02	70.34	58.04	81.51	68.04	71.38	99.82	80.93	80.19	100.80	94.94
" 18	68.23	93.27	70.37	71.15	63.04	80.70	71.39	75.84	101.25	84.42	75.98	102.27	86.79
" 19	70.98	83.96	70.37	66.70	59.60	76.82	72.80	77.50	102.11	82.19	71.09	98.58	88.94
" 20	78.42	81.47	70.37	66.69	65.81	79.40	66.11	73.31	101.52	87.88	72.50	86.06	89.96
" 21	74.43	82.22	70.37	70.36	76.56	80.16	52.41	69.99	111.24	86.39	72.88	89.38	82.83
" 22	73.96	81.45	71.73	68.04	66.89	80.75	41.94	73.80	116.00	87.21	62.04	85.22	89.25
" 23	80.75	80.17	68.79	62.79	65.98	80.21	65.13	75.86	110.37	76.45	72.82	86.01	88.37
" 24	80.39	79.51	67.21	62.87	71.67	89.11	57.68	72.12	100.45	76.41	75.38	80.86	81.64
" 25	78.81	81.90	67.44	65.65	63.47	87.87	59.48	74.90	98.12	78.66	75.38	81.03	84.81
" 26	61.21	82.78	67.21	66.40	69.20	82.20	60.20	73.87	100.64	77.76	75.89	82.25	86.73

TABLE NO. 4 . (Continued)

Average No. Lbs. Carbohydrates Consumed per Cow per Week During Lactation Period.

No. Cow	19	17	18	20	3	5	8	7	1	2	0	45	36
No. P'ds	3-1/2	3	1	3	4	3	2-1/2	4	3	3	1	1	1
Week 27	70.28	87.83	57.61	66.33	60.98	69.47	59.98	76.93	100.00	77.91	72.09	74,58	84.81
" 28	67.83	82.21	67.21	61.91	59.21	72.72	59.56	69.61	96.45	78.01	72.02	74.63	84.81
" 29	63.14	88.94	67.21	70.44	60.49	75.71	56.91	70.66	105.96	72.89	70.94	74.94	84.81
" 30	63.82	90.34	67.21	64.97	62.26	74.92	57.27	66.89	96.99	85.57	70.62	83.53	84.80
" 31	65.87	90.84	67.21	66.05	61.58	73.90	56.36	69.43	93.96	90.78	73.36	81.06	84.75
" 32	65.66	80.91	57.90	61.79	58.75	69.10	54.29	70.21	90.66	69.93	66.56	76.57	85.26
" 33	68.20	78.80	60.77	62.39	58.72	75.58	54.40	68.91	91.61	72.61	68.14	77.11	90.35
" 34	72.81	76.12	67.80	63.50	61.19	73.46	101.39	70.21	88.70	67.73	87.38	80.29	87.97
" 35	75.01	82.78	66.83	58.53	57.39	83.24	64.48	70.02	87.52	72.10	65.32	82.57	80.23
" 36	72.22	77.94	60.20	62.16	60.46	69.06	68.81	69.62	88.62	68.99	62.00	85.39	80.06
" 37	63.13	87.34	73.81	66.05	60.90	66.34	70.71	66.39	86.86	73.36	62.70	83.08	75.31
" 38	67.00	86.43	109.35	72.72	63.47	65.02	70.91	67.91	85.28	71.33	62.02	77.28	80.06
" 39	69.81	80.40	67.47	70.50	60.55	66.60	72.97	66.53	82.90	71.21	58.97	70.87	79.27
" 40	67.79	77.31	67.56	72.33	60.57	65.18	65.17	67.98	80.75	74.58	58.44	69.74	80.06
" 41	69.34	82.61	76.10	81.13	59.57	61.61	66.61	66.62	72.21	75.65	62.74	73.10	90.66
" 42	63.80	83.98	82.98	78.24	62.24	67.78	73.13	68.02	81.07	74.57	57.73	75.31	95.62
" 43	62.78	67.76	66.12	64.79	60.95	66.58	72.37	--.--	74.87	70.95	57.73	81.76	97.06
" 44	65.60	61.67	66.74	65.11	61.65	72.33	71.30	--.--	62.16	72.34	57.73	76.37	97.32
" 45	65.30	66.69	62.44	50.58	57.03	72.42	69.49	--.--	26.82	72.26	57.73	129.48	97.90
" 46	71.41	66.92	60.37	53.33	73.58	73.38	72.37	--.--	91.16	71.47	60.23	92.98	99.45
" 47	71.20	57.70	64.66	--.--	72.00	70.30	73.45	--.--	93.36	72.51	62.19	87.08	102.81
" 48	72.13	47.69	65.38	--.--	74.49	76.24	69.51	--.--	93.17	73.50	58.25	83.03	97.85
" 49	74.13	52.74	57.85	--.--	75.39	66.66	70.94	--.--	86.16	68.99	64.44	92.82	98.87
" 50	81.82	52.74	65.38	--.--	68.35	--.--	66.65	--.--	85.89	60.87	60.23	82.70	92.30
" 51	--.--	52.74	61.77	--.--	--.--	--.--	--.--	--.--	84.42	61.32	51.63	79.27	85.49
" 52	--.--	--.--	53.64	--.--	--.--	--.--	--.--	--.--	60.78	74.14	60.23	80.45	--.--

TABLE NO. 5.

Average No. Lbs. of Fat Consumed per Cow per Week During Lactation Period.

Cow No.	19	17	18	20	3	5	8	7	1	2	0	45	36
No. P'ds	3-1/2	3	1	3	4	3	2-1/2	4	3	3	1	1	1
Week 1	4.39	4.16	4.42	3.34	3.53	4.13	3.51	3.71	3.38	4.40	1.71	-.--	5.76
" 2	4.93	6.26	6.83	4.09	4.61	5.20	3.69	4.84	5.37	3.19	4.16	-.--	5.11
" 3	5.15	6.67	7.36	5.18	4.81	5.75	4.61	5.18	5.74	5.19	4.67	-.--	4.69
" 4	5.34	6.86	6.86	4.34	5.29	5.98	4.80	5.35	6.25	5.80	4.66	5.07	4.62
" 5	5.19	6.71	6.37	4.44	5.27	6.10	1.72	5.44	6.86	5.90	4.19	4.62	3.53
" 6	5.18	6.75	6.29	4.09	5.24	5.63	4.45	5.51	6.38	5.34	4.16	4.25	4.77
" 7	5.19	6.75	6.11	4.02	4.71	5.74	4.98	5.15	6.43	5.59	4.17	4.54	4.07
" 8	4.95	5.87	5.93	3.85	5.15	5.90	5.03	4.84	6.64	5.55	4.16	3.50	5.16
" 9	4.66	5.75	5.69	4.24	4.74	5.75	4.76	5.04	6.44	5.56	5.12	4.99	4.67
" 10	4.59	5.94	7.59	4.05	4.42	5.49	4.60	5.07	6.37	5.64	6.38	4.62	5.33
" 11	4.84	6.53	6.22	4.46	4.22	5.51	4.70	4.96	6.14	5.82	5.16	4.82	5.27
" 12	4.79	5.86	6.09	4.40	3.60	5.86	4.48	5.01	6.66	5.67	4.82	4.67	5.12
" 13	4.58	5.89	5.15	4.42	3.84	5.59	4.92	4.82	6.48	5.63	4.85	4.90	4.50
" 14	4.71	5.85	3.83	4.50	4.78	5.62	4.99	4.79	5.48	5.49	5.60	4.90	4.13
" 15	4.62	6.10	4.30	3.55	3.86	5.29	4.69	4.86	6.56	5.59	6.12	5.62	5.20
" 16	4.82	6.17	4.74	4.61	4.08	5.40	4.68	4.88	6.67	5.47	6.03	5.66	5.39
" 17	4.83	6.32	5.21	4.79	4.18	5.56	5.50	4.85	6.67	5.42	5.25	5.85	4.95
" 18	3.81	6.50	4.98	4.51	4.25	5.42	4.43	4.93	6.80	5.51	5.38	5.91	4.57
" 19	4.01	6.39	4.98	4.60	4.07	5.23	4.49	5.03	6.84	5.17	4.81	5.69	4.60
" 20	4.15	6.15	4.98	4.58	4.15	5.25	4.20	4.81	6.81	5.11	5.07	5.41	4.67
" 21	4.77	5.54	4.98	4.63	4.70	5.29	4.25	4.41	7.35	5.09	5.10	5.24	4.45
" 22	4.70	5.78	5.07	4.43	4.26	5.31	4.30	4.55	7.45	5.15	4.17	5.11	4.72
" 23	4.66	5.79	4.83	4.47	4.21	5.29	4.41	4.64	7.35	4.79	5.05	5.14	4.72
" 24	4.94	5.74	4.70	4.24	4.47	5.24	3.98	4.54	6.93	4.78	5.22	4.98	4.52
" 25	4.68	5.58	4.72	4.35	4.14	5.21	4.10	4.53	6.87	4.85	5.22	4.98	4.61
" 26	4.19	5.47	4.70	4.38	4.17	5.06	4.13	4.60	6.96	4.63	5.25	5.02	4.61

TABLE NO. 5 . (Continued)

Average No. Lbs. of Fat Consumed per Cow per Week During Lactation Period.

Cow No. No. P'ds	19 3-1/2	17 3	18 1	20 3	3 4	5 3	8 2-1/2	7 4	1 3	2 3	0 1	45 1	36 1
Week 27	4.34	5.32	4.03	4.41	4.02	4.38	4.11	4.73	6.84	4.61	4.86	4.69	4.61
" 28	4.41	4.95	4.70	4.36	3.97	4.55	4.10	4.71	6.71	4.87	4.87	4.57	4.61
" 29	4.18	5.34	4.70	4.32	3.89	4.72	3.88	4.40	7.42	4.89	4.82	4.63	4.61
" 30	4.44	5.34	4.70	4.70	3.92	4.69	3.89	4.22	6.75	5.33	4.80	4.84	4.61
" 31	3.97	5.54	4.70	3.63	3.66	4.63	3.81	4.44	6.65	5.41	5.04	4.66	4.62
" 32	4.03	5.56	4.26	4.72	3.50	4.28	3.62	4.42	6.41	4.51	4.42	4.36	4.78
" 33	3.97	5.13	4.40	3.78	3.48	4.71	4.10	4.26	6.15	4.72	4.56	4.36	4.71
" 34	4.01	5.25	4.80	4.29	3.54	4.26	6.34	4.40	6.04	4.70	5.84	4.53	4.33
" 35	4.31	5.36	4.69	3.12	3.59	5.00	4.51	4.41	6.12	4.45	4.31	4.81	4.32
" 36	4.28	5.45	4.36	3.82	4.38	4.43	4.81	3.09	6.18	4.91	4.04	4.88	4.18
" 37	4.21	5.37	4.70	4.02	4.08	4.52	4.95	4.40	6.03	5.01	4.18	4.77	4.32
"" 38	4.61	5.54	6.36	4.16	5.41	4.29	4.97	4.45	5.87	4.86	4.12	4.48	4.31
" 39	4.28	5.41	4.37	4.05	4.06	4.47	5.19	4.41	5.68	4.84	3.91	4.03	4.32
" 40	4.22	5.42	4.40	4.07	4.18	4.41	5.24	4.51	5.53	4.97	3.90	3.95	4.08
" 41	4.49	4.83	4.59	4.15	3.90	4.13	4.68	4.49	4.86	4.99	4.10	4.06	4.14
" 42	4.48	4.97	4.50	4.12	4.36	4.70	4.53	4.44	3.89	4.85	3.86	4.19	4.18
" 43	4.46	4.86	4.29	3.83	4.14	4.49	4.91	-.--	3.56	4.66	3.86	3.81	4.19
" 44	4.15	3.80	4.34	3.52	4.27	4.79	4.89	-.--	2.87	4.67	3.86	3.36	4.21
" 45	4.32	3.63	4.06	3.97	4.13	4.79	4.84	-.--	1.12	4.64	3.86	5.17	4.37
" 46	4.62	4.23	3.91	4.05	3.63	4.82	4.68	-.--	4.87	4.16	3.98	4.06	4.59
" 47	4.77	4.47	4.11	4.73	4.79	4.67	4.89	-.--	5.04	4.70	4.13	3.58	4.39
" 48	4.67	4.31	4.14	2.51	5.00	4.90	4.95	-.--	5.03	4.51	3.89	3.48	4.81
" 49	4.62	3.46	3.71	-.--	5.05	4.17	4,94	-.--	5.65	4.37	4.25	4.27	4.84
" 50	4.59	2.81	4.14	-.--	4.46	3.49	4.75	-.--	5.64	3.88	3.98	3.94	4.48
" 51	4.68	3.02	3.82	-.--	-.--	-.--	4.82	-.--	3.89	3.86	3.41	4.22	4.49
" 52	4.58	-.--	3.10	-.--	-.--	-.--	4.62	-.--	3.33	3.61	3.98	4.48	4.48

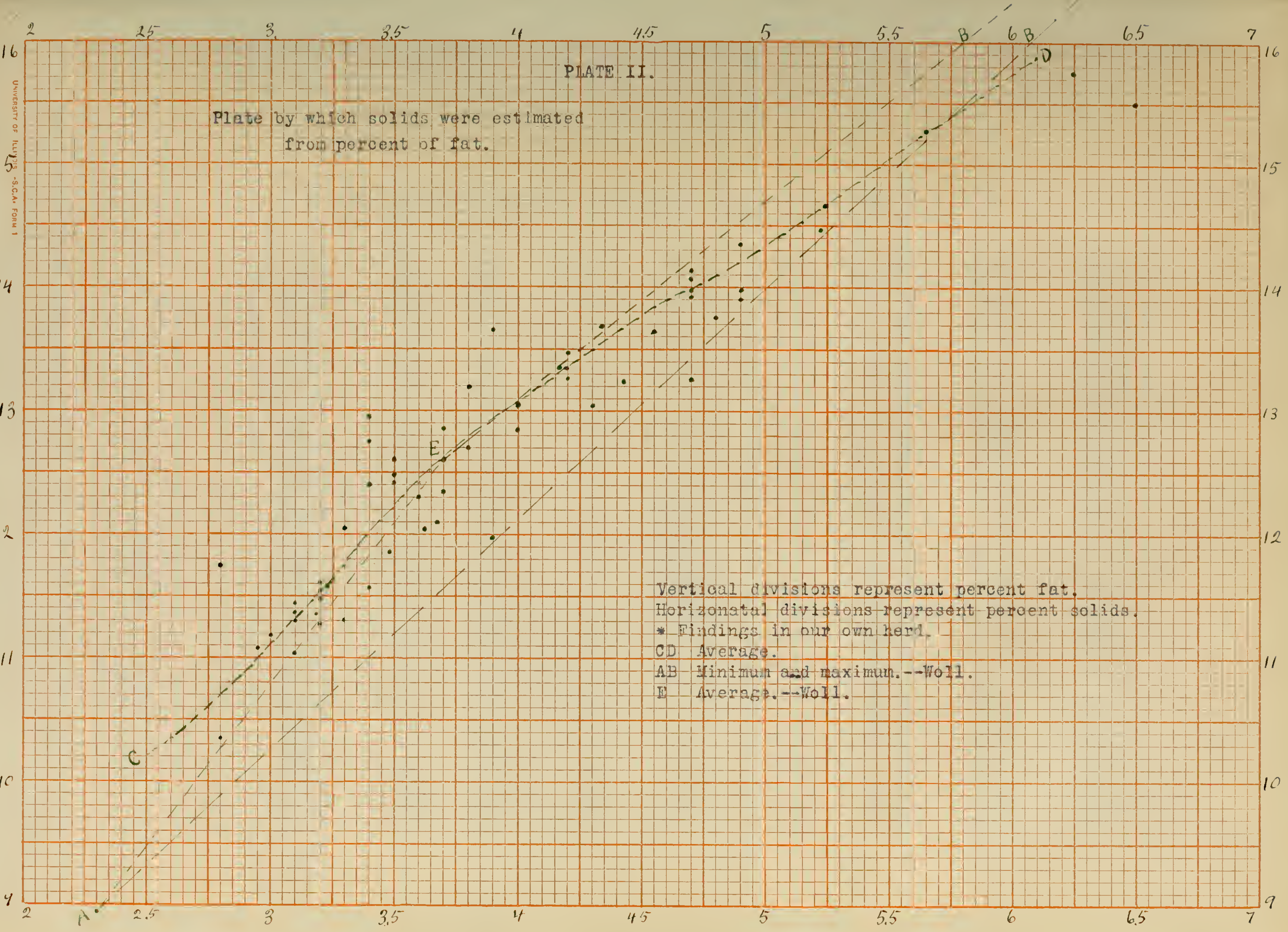


PLATE II.

Plate by which solids were estimated
from percent of fat.

Vertical divisions represent percent fat.
Horizonatal divisions represent percent solids.
* Findings in our own herd.
CD Average.
AB Minimum and maximun.--Woll.
E Average.--Woll.

TABLE NO. 6.

Average Amount of Materials Produced and Digestible Nutrients Consumed per Week by 13 Cows During 33 Lactation Periods.

	Lbs. Milk	% Fat	Lbs. Fat.	(Est.) % Solids	Lbs. Solids.	Lbs. Protein	Carbo-hydrates	2-1/4 x Fat	Total Nutrients
Week 1	167.80	3.7	6.26	12.6	21.14	10.86	58.86	8.71	78.43
" 2	235.67	3.8	8.99	12.8	30.17	13.47	73.73	10.94	98.14
" 3	244.32	3.7	9.12	12.6	30.78	14.68	78.10	12.20	104.98
" 4	247.70	3.7	9.10	12.6	30.58	15.29	80.76	12.33	108.38
" 5	237.30	3.6	8.62	12.5	29.66	15.10	77.10	11.48	103.68
" 6	230.20	3.7	8.66	12.6	29.01	14.14	77.99	11.77	103.90
" 7	209.76	3.8	8.15	12.8	26.85	14.68	76.76	11.68	103.12
" 8	221.51	3.7	8.16	12.6	27.91	14.81	76.73	11.52	103.06
" 9	215.56	3.6	7.86	12.5	26.95	15.25	78.20	11.68	105.13
" 10	209.61	3.6	7.69	12.5	26.20	14.28	81.50	12.13	107.91
" 11	227.57	3.4	7.91	12.0	27.31	15.43	79.28	11.88	106.59
" 12	199.48	3.7	7.39	12.6	25.13	15.15	77.20	11.61	103.96
" 13	187.18	3.7	7.03	12.6	23.58	15.41	75.65	11.00	102.06
" 14	184.80	3.7	6.93	12.6	23.28	15.37	75.39	11.18	101.94
" 15	187.91	3.7	7.00	12.6	23.68	16.79	80.01	11.48	108.28
" 16	185.70	3.7	6.90	12.6	23.40	16.42	81.65	11.88	109.95
" 17	181.64	3.6	6.68	12.5	22.71	16.89	80.10	12.02	109.01
" 18	179.43	3.7	6.66	12.6	22.61	16.60	80.36	11.59	108.55
" 19	174.98	3.3	6.48	11.8	20.65	16.68	78.59	11.41	106.68
" 20	172.45	3.7	6.42	12.6	21.73	16.42	78.42	11.32	106.16
" 21	177.30	3.6	6.48	12.5	22.16	16.16	78.40	11.39	105.95
" 22	165.13	3.9	6.21	12.9	21.30	15.71	76.79	11.25	103.75
" 23	162.58	3.8	6.22	12.8	20.81	16.00	77.98	11.32	105.30
" 24	157.86	3.8	6.14	12.8	20.21	15.63	76.56	11.12	103.31
" 25	161.70	3.6	5.96	12.5	20.21	15.67	76.73	11.05	103.45
" 26	158.93	3.7	5.88	12.6	20.03	15.94	75.87	10.94	102.75

TABLE NO. 6. (Continued)

Average Amount of Materials Produced and Digestible Nutrients
Consumed per Week by 13 Cows During 33 Lactation Periods.

	Lbs. Milk	% Fat	Lbs. Fat.	(Est.) % Solids	Lbs. Solids.	Lbs. Protein	Carbo-hydrates	2-1/4 x Fat	Total Nutrients
Week 27	141.67	3.7	5.33	11.2	15.87,	14.88	73.75	10.55	99.18
" 28	147.15	3.7	5.53	12.6	18.54	15.14	72.78	10.62	98.54
" 29	141.78	3.1	5.50	11.3	16.02	15.25	74.08	10.69	100.02
" 30	137.92	3.8	5.30	12.8	17.65	15.21	74.40	10.78	100.39
" 31	133.22	3.7	5.02	12.6	16.79	15.17	75.01	10.51	100.69
" 32	129.84	3.7	4.84	12.6	16.36	14.81	69.81	10.20	94.82
" 33	127.10	3.7	4.76	12.6	16.01	14.54	71.35	10.10	95.99
" 34	124.62	3.7	4.73	12.6	15.70	15.45	77.58	10.78	103.81
" 35	125.20	3.6	4.52	12.5	15.65	14.38	92.77	10.20	117.35
" 36	116.20	3.8	4.38	12.8	14.87	13.44	71.27	10.17	94.88
" 37	115.48	3.8	4.39	12.8	14.78	13.66	77.38	10.49	101.53
" 38	108.71	3.8	4.17	12.8	13.91	13.46	75.29	10.98	99.73
" 39	104.01	3.8	3.99	12.8	13.31	13.69	70.62	10.22	94.53
" 40	97.02	3.9	3.79	12.9	12.52	13.95	69.81	10.20	93.96
" 41	95.06	3.9	3.75	12.9	12.26	13.93	72.15	9.95	96.03
" 42	90.17	3.8	3.51	12.8	11.54	14.52	74.19	9.88	98.59
" 43	94.45	4.0	3.82	13.1	12.37	13.72	70.31	9.56	93.59
" 44	92.85	3.6	3.36	12.5	11.61	14.61	69.19	9.05	92.85
" 45	73.10	4.5	3.30	13.7	10.01	12.98	69.01	9.16	91.15
" 46	82.81	4.0	3.32	13.1	10.85	14.26	73.89	9.68	97.83
" 47	76.49	4.1	3.18	13.2	10.10	14.66	75.21	10.17	100.04
" 48	74.98	4.1	3.14	13.2	9.90	15.92	73.75	9.79	99.46
" 49	70.60	4.3	3.04	13.5	9.53	13.10	73.54	10.08	96.72
" 50	62.89	4.4	2.80	13.6	8.55	11.80	71.69	9.45	92.94
" 51	59.99	6.0	3.60	15.7	9.42	12.53	68.09	9.05	89.67
" 52	47.84	6.9	3.32	16.6	7.94	12.66	67.85	9.05	89.56

TABLE NO. 7.

Lbs. Digestible Nutrients Used in the Production of 1 lb. Milk Solids.

Average for 13 Cows During 33 Lactation Periods.

		Total Solids.	Protein	Carbo-hydrates	2-1/4 x Fat	Total Nutrients
Week	1	21.14	.51	2.78	.31	3.71
"	2	30.17	.44	2.44	.36	3.25
"	3	30.78	.47	2.53	.39	3.41
"	4	30.58	.50	2.64	.40	3.54
"	5	29.66	.50	2.59	.38	3.49
"	6	29.01	.48	2.68	.40	3.58
"	7	26.85	.54	2.85	.43	3.84
"	8	27.91	.53	2.74	.41	3.69
"	9	26.95	.56	2.90	.43	3.90
"	10	26.20	.54	3.11	.46	4.11
"	11	27.31	.56	2.90	.43	3.90
"	12	25.13	.60	3.07	.46	4.13
"	13	23.58	.65	3.20	.46	4.75
"	14	23.28	.66	3.28	.48	4.37
"	15	23.68	.70	3.37	.48	4.57
"	16	23.40	.70	3.48	.50	4.69
"	17	22.71	.74	3.52	.52	4.80
"	18	22.61	.73	3.55	.51	4.80
"	19	20.65	.80	3.80	.55	5.11
"	20	21.73	.75	3.60	.52	4.88
"	21	22.16	.72	3.53	.55	4.78
"	22	21.30	.73	3.60	.52	4.87
"	23	20.81	.76	3.74	.54	5.06
"	24	20.21	.77	3.78	.55	5.11
"	25	20.21	.77	3.78	.54	5.11
"	26	20.03	.79	3.78	.54	5.12
"	27	15.87	.93	4.64	.66	6.25
"	28	18.54	.81	3.92	.57	5.31
"	29	16.02	.95	4.62	.66	6.25
"	30	17.65	.86	4.21	.61	5.69
"	31	16.79	.90	4.50	.62	5.99
"	32	16.36	.90	4.27	.62	5.18
"	33	16.01	.90	4.45	.63	5.99
"	34	15.70	.98	4.94	.68	6.61
"	35	15.65	.91	5.92	.65	7.49
"	36	14.87	.90	4.79	.68	6.38

TABLE NO. 7. (Continued)

Lbs. Digestible Nutrients Used in the Production of 1 lb. Milk Solids.

Average for 13 Cows During 33 Lactation Periods.

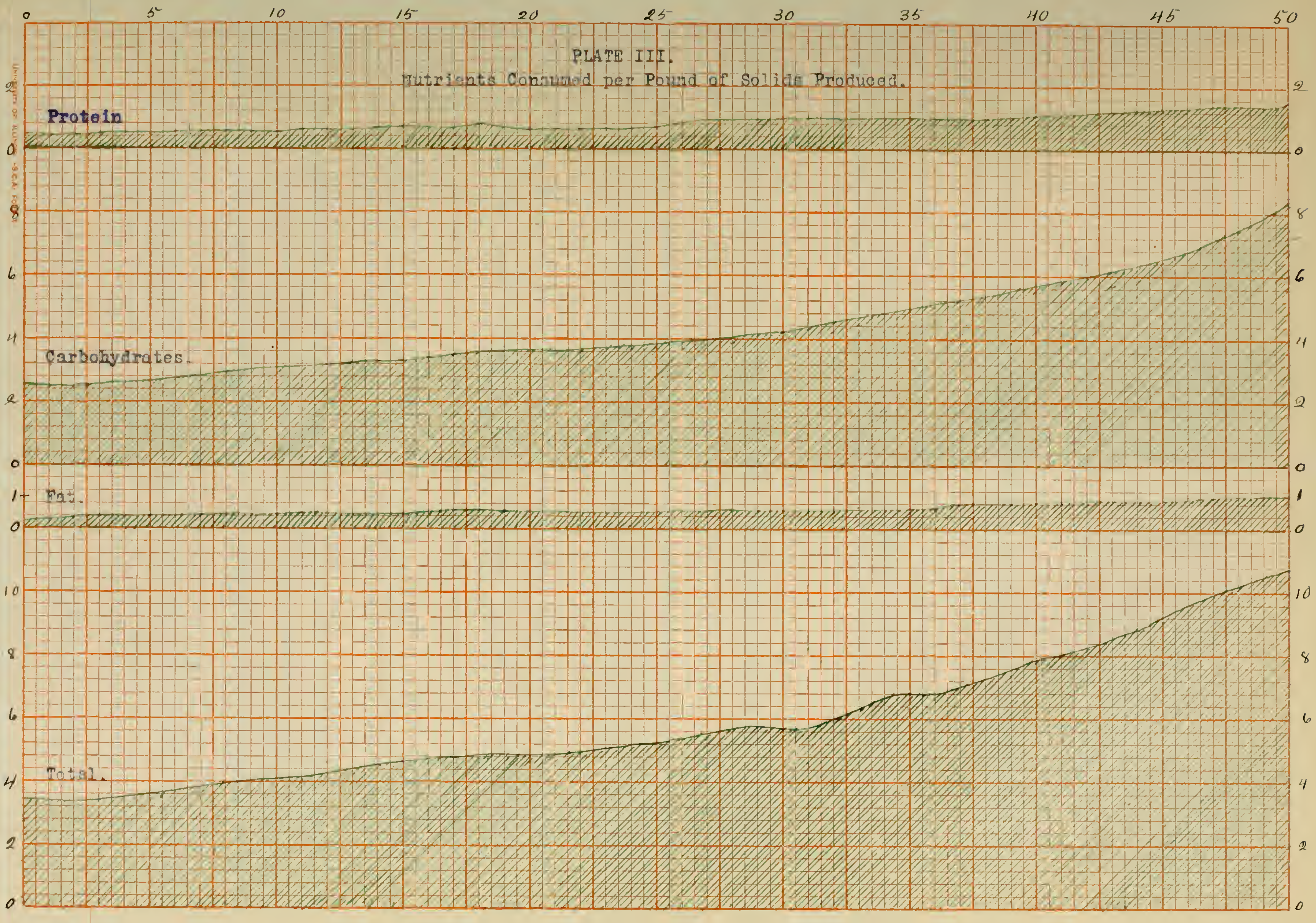
	Total Solids.	Protein	Carbo-hydrates	2-1/4 x Fat	Total Nutrients
Week 37	14.78	.92	5.23	.71	6.87
" 38	13.91	.96	5.41	.79	7.18
" 39	13.31	1.02	5.30	.76	7.10
" 40	12.52	1.11	5.57	.81	7.50
" 41	12.26	1.13	5.88	.81	7.83
" 42	11.54	1.25	6.42	.85	8.54
" 43	12.37	1.10	5.68	.77	7.55
" 44	11.60	1.25	5.96	.78	8.00
" 45	10.01	1.29	6.89	.91	9.10
" 46	10.85	1.31	6.81	.89	9.01
" 47	10.10	1.45	7.44	1.00	9.90
" 48	9.90	1.60	7.45	.98	10.04
" 49	9.53	1.37	7.71	1.05	10.14
" 50	8.55	1.38	8.38	1.10	10.87
" 51	9.42	1.33	7.22	.96	9.51
" 52	7.94	1.59	8.54	1.13	11.28

Average for the 52 Weeks.

	Protein	Carbo.	Fat	Total
Per Pound Solids,	.78	4.01	.253	5.043
" " Fat,	2,59	13.31	.835	16.735
" " Milk,	.1034	.5307	.0333	.6674
Haecker's Standard,	.0871	.619	.0217	.7278

PLATE III.

Nutrients Consumed per Pound of Solids Produced.



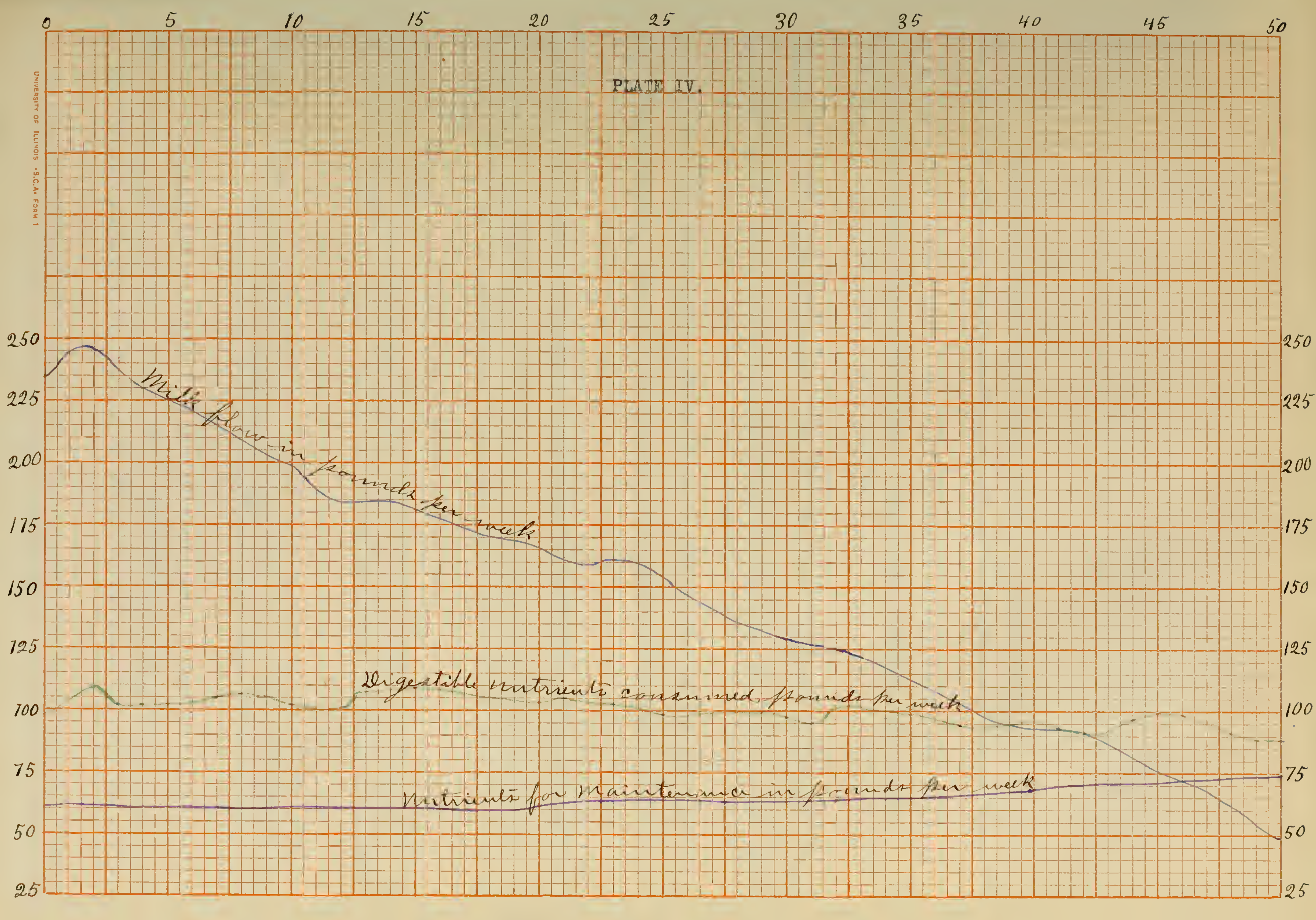
This table shows a constant increase of nutrients required per pound of product from the beginning to the end of the lactation period. It is graphically illustrated by plate III. The amount consumed per pound of solids at the end of the period is about four times that consumed per pound of solids at the beginning of the period.

The second part of the table shows the average for the entire time, not only for the milk solids, but also for the milk and fat. The amount consumed per pound of milk is compared with the requirements as given by Haecker. It is difficult to compare the amount consumed perpound of solids with Haecker's standard, since the standard is based on milk and fat alone. The table shows that the cows under test consumed .0163 pound more protein, .0783 pound less carbohydrates and .0116 pound more fat than called for by the standard. Of total nutrients on the same basis theyconsumed .0604 pound less. According to Haecker, more protein was consumed than was necessary. This is perhaps true, especially during the latter part of the period. However, had this been withheld, it is a question whether the other nutrients would have been as efficient. On this, note the findings in connection with table 34.

In all the above calculations, the nutrients required for maintenance are included. During the latter part of the periods the weight of the animals increased materially, due to the growth of the foetus. In calculating the nutrients for maintenance, this increased weight due to the foetus was included in determining the average weight of the animal, assuming that it required as much for a pound increase in this as for a pound of added body weight. This assumption may be wide of the mark. The factors used for maintenance were .7 pound protein, .7 pound carbohydrates and .1 pound fat per 1000 pounds live weight.

The relation of the nutrients required for maintenance to the total nutrients consumed and milk produced is shown graphically by plate four.

PLATE IV.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25
30
35
40
45
50
250
225
200
175
150
125
100
75
50
25
Milk flow in pounds per week
Digestible nutrients consumed, pounds per week
Nutrients for Maintenance in pounds per week
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The horizontal divisions represent pounds per week and the vertical represent weeks.

Were we to exclude maintenance the difference between the requirements in the early and latter part of the period would not be so great, due to the requirements of the foetus.

In comparing these results with those of Professor Haecker, it is only fair to state that the cattle used by him in arriving at his standard were of uniform breeding, and were uniformly good producers and of good dairy type. His work was done during the winter months, perhaps seven months, covering the best part of the lactation period. After this they were turned to grass. The reader will note that in the preceding tables the period extends through the entire lactation period, or for the entire year. The cows were for the entire time on dry feed,--some of them for four years, except for a little soiling given during about one month. The results, then, from our experiment, might well be expected to be higher, which they are not.

From a practical standpoint, the amount of materials consumed during the entire year, whether the cow is in milk or not, is of prime importance. The yearly consumption charged against the yearly production is the true measure of the economic value of the animal.

This is taken into consideration in part two.

PART II.

In the following data, each cow is considered separately. In the tables are shown the amount of products yielded, the amount of nutrients consumed (Including and excluding maintenance), the nutritive ratio, nutrients consumed per unit of milk, the nutrients consumed per unit of fat, and the nutrients consumed per unit of milk solids. Each yearly record is given separately, and the totals for the entire time.

Cow 19.

The tables 8 and 9 give results for this cow. She was a large pure-bred Holstein, but not of very good dairy form, and had long been recognized as the poorest producer in the herd. In no case did she produce 200 pounds of fat in a year.

Of the nutrients consumed, 82.71 per cent was necessary for maintenance, (according to the standard), leaving only 17.29 per cent available for production.

In part two of table 8 a seemingly absurd thing appears: during the second and third year. she consumed less carbohydrates than was required for maintenance. This, of course, was overcome by the excess of fat and protein above maintenance. However, the writer feels certain that had a correct analysis of the silage been available, the result would have been different.

Table 9 shows that, including maintenance, a large amount of nutrients was required per unit of product. When maintenance is excluded the opposite is true.

While under test she was 5-1/2 months dry and gave birth to three calves.

In economy of production she stands 12th in milk, 13th in fat and 13th in solids.

12.3 pounds milk per day for entire time.

	Protein	Carbo.	Fat	Total.
Nutrients per pound of milk,	.1472	.7585	.0483	1.0144
Called for by standard,	.1290	.9503	.0255	1.1366

TABLE NO. 8.

Cow No. 19.

Lbs. Milk, Fat and Solids Produced and Nutrients Consumed.

	Milk.	% Fat	Fat.	% Solids	Solids	Protein.	Carbo-hydrates	Fat.	N. R.
First year,	3677.90	3.46	127.37	12.1	445.02	658.69	3608.43	249.84	1:6.3
Second year,	5071.40	3.51	178.20	12.4	628.85	584.30	3109.77	203.11	1:6.9
Third year,	4410.70	3.36	148.51	11.9	524.87	659.74	3334.50	206.08	1:5.7
Fourth year,	4924.30	3.14	154.94	11.4	561.37	759.08	3364.59	214.56	1:5.1
Total,	18084.30	3.36	609.02	11.9	2160.11	2661.81	13717.29	873.59	

Average Weight of Cow, 1312 lbs.

	Protein.	Carbo.	Fat
Maintenance for one year,	335.22	3352.20	47.89
Consumed above Maintenance 1st year,	323.47	256.23	201.95
" " " 2nd year,	249.08	- 242.43	155.22
" " " 3d year,	324.52	- 17.70	158.19
" " " 4th year,	423.86	12.39	168.67
Total,	1320.93	8.49	684.03

TABLE NO. 9.

Cow No. 19.

Lbs. Nutrients Consumed per Unit of Production.

Including Maintenance.

	Per 100# Milk			Per 1# Fat			Per 100# Solids		
	Protein.	Carbo.	Fat	Protein	Carbo.	Fat	Protein.	Carbo.	Fat
First year,	17.909	98.100	6.793	5.171	28.330	1.961	148.01	810.84	56.14
Second year,	11.521	61.319	4.005	3.278	17.451	1.139	92.91	495.51	32.29
Third year,	14.957	75.600	4.672	4.442	22.453	1.388	125.69	635.30	39.26
Fourth year,	15.415	68.326	4.357	4.899	21.715	1.384	135.21	599.35	38.22
Average, 4 years,	14.718	75.851	4.830	4.370	22.525	1.433	123.22	635.02	46.44

Excluding Maintenance.

	Per 100# Milk			Per 1# Fat			Per 100# Solids		
	Protein.	Carbo.	Fat	Protein	Carbo.	Fat	Protein.	Carbo.	Fat
First year,	8.794	6.966	5.490	2.539	2.011	1.585	72.68	57.57	45.37
Second year,	4.911	-4.780	3.060	1.398	-1.359	.871	39.61	-38.55	24.68
Third year,	7.357	- .401	3.586	2.185	- .119	1.065	61.82	- 3.37	30.13
Fourth year,	8.608	.251	3.425	2.735	.080	1.080	75.50	2.21	30.04
Average, 4 years,	7.304	.047	3.78	2.168	.001	1.123	61.15	.392	31.66

Cow 17.

The results from cow 17 are given in tables 10 and 11. She was a pure-bred Holstein taken from the University herd, was of much better dairy form than cow 19, and proved to be one ofthe most economical producers.

60.47 per cent of the nutrients consumed was used for maintenance, leaving 39.53 per cent available for production.

The table shows a decrease from year to year in production, which was undoubtedly due to the fact that she was an old cow and had passed the period of most economical production.

During the time under test she gave birth to two calves, carried a third at the time the experiment closed, and was dry a total of four months.

In economy of production she stands second in milk, sixth in fat and third in milk solids.

27.3 pounds of milk per day for entire time.

	Protein.	Carbo.	Fat	Total
Nutrients per pound of milk,	.08692	.4178	.0269	.5652
Called for by standard,	.07086	.4926	.01805	.60407

TABLE NO. 10.

Cow No. 17.

Lbs. Milk, Fat and Solids Produced and Nutrients Consumed.

	Milk	% Fat	Fat.	% Solids	Solids	Protein.	Carbo-hydrates	Fat.	N. R.
First year,	12047.70	3.35	403.66	11.9	1433.67	881.53	4328.20	307.70	1:6.7
Second year,	9850.50	3.11	306.69	11.3	1131.06	898.18	4240.69	274.65	1:5.4
Third year,	8056.40	2.57	207.85	10.3	829.80	824.19	3947.49	223.51	1:5.3
Total,	29954.60	3.08	918.20	11.3	3394.53	2603.90	12516.38	805.86	

Average Weight of Cow, 1218 lbs.

	Protein.	Carbo.	Fat
Maintenance for one year,	311.20	3111.99	44.46
Consumed above Maintenance 1st year,	570.33	1216.21	263.24
" " " 2nd "	586.98	1128.70	230.19
" " " 3d "	512.99	835.50	179.05
Total,	1671.30	3181.41	672.48

TABLE NO. 11.

Cow No. 17.

Lbs. Nutrients Consumed per Unit of Product.

Including Maintenance.

	Per 100# Milk			Per 1# Fat			Per 100# Solids		
	Protein	Carbo.	Fat	Protein	Carbo.	Fat.	Protein	Carbo.	Fat
First year,	7.316	35.925	2.554	2.183	10.722	.762	61.49	301.89	21.46
Second year,	9.118	43.050	2.788	2.928	13.827	.895	79.41	374.93	19.76
Third year,	10.230	48.997	2.774	3.965	18.992	1.075	99.32	475.72	26.94
Average, 3 years,	8.692	41.784	2.690	2.835	13.631	.877	76.71	368.72	23.74

Excluding Maintenance.

	Per 100# Milk			Per 1# Fat			Per 100# Solids		
	Protein	Carbo.	Fat	Protein	Carbo.	Fat.	Protein	Carbo.	Fat
First year,	4.733	10.094	2.109	1.412	3.012	.652	39.78	84.84	18.36
Second year,	5.958	11.458	2.336	1.913	3.680	.750	51.89	99.79	20.35
Third year,	6.367	10.366	2.222	2.468	4.019	.861	61.82	100.69	21.58
Average, 3 years,	5.579	10.620	2.245	1.820	3.465	.732	49.24	93.72	19.81

Cow 18.

The results from cow 18 are given in tables 12 and 13. She was a pure-bred Holstein from the University herd and of moderately good dairy form, though rather light in body.

Of the nutrients consumed, 67.18 per cent was required for maintenance, leaving 32.82 per cent available for production.

She was dry two months and gave birth to one calf.

In economy of production she stands fourth in milk, eighth in fat and sixth in solids.

22.8 pounds of milk daily for entire time.

	Protein	Carbo.	Fat	Total
Nutrients per pound of milk,	.0843	.4452	.0296	.5961
Called for by standard,	.0747	.5310	.0188	.6480

TABLE NO. 12. Cow No. 18.

Lbs. Milk, Fat and Solids Produced and Nutrients Consumed.

	Milk.	% Fat.	Fat.	% Solids	Solids	Protein.	Carbo-hydrates	Fat.	N. R.
First year,	8675.70	3.04	264.57	11.2	971.67	746.32	3796.72	254.81	1:5.8
Second 1/2 yr.	3805.70	3.21	122.24	11.5	437.65	306.36	1760.34	115.54	1:6.5
Total,	12481.40	3.09	386.81	11.2+	1409.32	1052.69	5557.06	370.35	

Average Weight of Cow, 1183 lbs.

	Protein.	Carbo.	Fat
Maintenance for one year,	292.25	2922.56	42.08
Consumed above Maintenance 1st year,	454.06	874.16	212.73
" " " 2nd 1/2 yr.	160.02	299.06	94.50
Total,	614.08	1173.22	307.23

TABLE NO..13. Cow No. 18.

Lbs. Nutrients Consumed per Unit of Product.

Including Maintenance.

	Per 100# Milk.			Per 1# Fat.			Per 100# Solids		
	Protein	Carbo.	Fat	Protein	Carbo.	Fat.	Protein.	Carbo.	Fat.
First year,	8.602	43.762	2.937	2.821	14.350	.963	76.807	390.741	39.074
Second 1/2 year,	8.050	46.255	3.036	2.506	14.400	.945	70.001	402.225	26.400
Average, 1-1/2 yr.	8.430	44.52	2.96	2.721	14.366	.957	74.694	394.307	26.278
Excluding Maintenance.									
First year,	5.234	10.076	2.452	1.716	3.304	.804	46.729	89.964	21.893
Second 1/2 year,	4.204	7.858	2.483	1.309	2.446	.773	36.563	68.333	21.592
Average, 1-1/2 yr.	4.92	9.11	2.46	1.587	3.033	.794	43.572	83.247	21.799

Cow 20.

The results from cow number twenty are given in tables 14 and 15. She was a pure-bred Guernsey from the University herd, and of poor dairy form.

Of the nutrients consumed, 51.01 per cent was required for maintenance, leaving 48.99 per cent available for production.

She was in the experiment three years, was dry five months, and gave birth to three calves.

In economy of production she stands eighth in milk, fourth in fat and seventh in milk solids.

15.8 pounds of milk per day during the entire time.

	Protein	Carbo.	Fat	Total
Nutrients per pound of milk,	.1242	.5767	.0367	.7834
Called for by standard,	.0887	.6010	.0237	.7430

TABLE NO. 14. Cow No. 20.

Lbs. Milk, Fat and Solids Produced and Nutrients Consumed.

	Milk.	% Fat	Fat.	% Solids	Solids	Protein.	Carbo-hydrates	Fat.	N.R.
First year,	4336.01	5.30	230.14	14.8	641.73	571.32	2972.24	199.24	1:5.9
Second year,	6223.70	5.03	313.44	14.4	896.21	705.13	3282.64	208.78	1:5.3
Third year,	6812.10	4.71	321.01	14.0	953.69	881.02	3763.40	229.00	1:4.9
Total,	17371.90	5.00	864.59	14.3	2497.20	2157.47	10018.28	637.02	

Average Weight of Cow, 800 lbs.

	Protein.	Carbo.	Fat.
Maintenance for one year,	204.40	2044.00	29.2
Consumed above Maintenance 1st year,	366.92	928.24	170.04
" " " 2nd year,	500.73	1238.64	179.58
" "" " 3d year,	676.62	1719.40	199.20
Total,	1544.27	3886.28	548.82

TABLE NO. 15. Cow No. 20.

Lbs. Nutrients Consumed per Unit of Product.

Including Maintenance.

	Per 100# Milk.			Per 1# Fat.			Per 100# Solids		
	Protein	Carbo.	Fat	Protein	Carbo.	Fat.	Protein	Carbo.	Fat
First year,	13.175	68.547	4.595	2.482	12.914	.865	89.02	463.16	31.04
Second year,	11.329	52.744	3.354	2.249	10.472	.666	78.67	366.28	23.29
Third year,	12.933	55.245	3.361	2.744	11.723	.713	92.38	394.61	24.01
Average, 3 years,	12.419	57.669	3.666	2.495	11.587	.736	86.39	401.18	25.50

Excluding Maintenance.

	Per 100# Milk.			Per 1# Fat.			Per 100# Solids		
	Protein	Carbo.	Fat	Protein	Carbo.	Fat.	Protein	Carbo.	Fat
First year,	8.462	21.407	3.921	1.594	4.033	.738	57.17	144.64	26.55
Second year,	8.045	19.901	2.884	1.596	3.951	.572	55.87	138.20	20.03
Third year,	9.932	25.240	2.924	2.107	5.355	.620	70.94	180.28	20.88
Average, 3 years,	8.889	22.371	3.159	1.786	4.494	.634	61.84	155.62	21.97

Cow 3.

The results from cow number three are given in tables 16 and 17. She was a grade cow with more of a beef than dairy form and was selected from a dairy herd in the Elgin district as an example of a poor cow for dairy purposes. She was not an economic producer, using all of the nutrients consumed for maintenance, except 5.29 per cent.

This cow continued four years in the experiment, and was dry nine months and gave birth to three calves.

The same thing happens in the record of this cow as in that of 19:---during the last three years it shows a deficiency in carbohydrates for maintenance.

In economy of production she stands 13th in milk, 12th in fat and 12th in milk solids.

12.05 pounds of milk per day during entire period.

	Protein	Carbo.	Fat	Total.
Nutrients per pound of milk,	.12924	.6911	.04508	.92177
Called for by standard,	.1064	.8450	.0233	1.0038

TABLE NO 16.

Cow No. 3.

Lbs. Milk, Fat and Solids Produced and Nutrients Consumed.

	Milk	% Fat.	Fat.	% Solids	Solids	Protein.	Carbo-hydrates	Fat.	N. R.
First year,	5308.90	3.68	195.50	12.6	668.92	633.34	3629.90	247.03	1:6.6
Second year,	4542.40	3.68	167.17	12.6	572.34	529.02	2927.39	196.09	1:6.3
Third year,	3887.70	3.50	136.36	12.2	474.29	554.88	2709.29	175.89	1:6.5
Fourth year,	3863.20	3.26	126.16	11.9	459.73	557.75	2900.26	174.53	1:5.0
Total,	17602.20	3.08	625.19	12.3	2175.32	2274.99	12166.84	793.54	

Average Weight of Cow, 1310 lbs.

	Protein.	Carbo.	Fat.
Maintenance for one year,	334.70	3347.00	47.81
Consumed above Maintenance 1st year,	298.64	282.90	199.22
" " " 2nd "	194.32	- 419.61	148.28
" " " 3d "	220.18	- 637.71	128.08
" " " 4th "	223.05	- 446.74	146.52
Total,	936.19	- 1221.16	622.10

TABLE NO. 17.

Cow No. 3.

Lbs. Nutrients Consumed per Unit of Product.

Including Maintenance.

	Per 100# Milk.			Per 1# Fat.			Per 100# Solids.		
	Protein.	Carbo.	Fat	Protein	Carbo.	Fat	Protein	Carbo.	Fat
First year,	11.929	68.373	4.653	3.239	18.567	1.263	94.68	542.66	36.92
Second year,	11.646	64.445	4.317	3.164	17.511	1.172	92.43	511.30	29.54
Third year,	14.272	69.688	4.524	4.069	19.868	1.289	116.99	571.23	37.08
Fourth year,	14.437	75.074	4.517	4.420	22.988	1.383	121.32	630.86	37.96
Average, 4 years,	12.924	69.115	4.508	3.638	19.461	1.269	104.56	559.47	36.58

Excluding Maintenance.

	Per 100# Milk.			Per 1# Fat.			Per 100# Solids.		
	Protein.	Carbo.	Fat	Protein	Carbo.	Fat	Protein	Carbo.	Fat
First year,	5.625	5.328	3.752	1.527	1.447	1.012	44.64	42.29	29.78
Second year,	4.277	- 9.234	3.264	1.162	- 2.510	.887	33.95	- 73.31	25.90
Third year,	5.663	-16.403	3.294	1.614	- 4.676	.939	46.42	-134.45	27.00
Fourth year,	5.773	-11.564	3.792	1.767	- 3.541	1.161	48.51	- 97.18	31.87
Average, 4 years,	5.318	- 6.937	3.534	1.497	- 2.360	.995	43.03	- 56.14	28.60

Cow 5.

Number five was a grade cow carrying a good deal of flesh, but not approaching the beef form as closely as number three. She was evidently largely of Shorthorn breeding, and was also selected as a poor cow for dairy purposes.

After deducting maintenance, of the nutrients consumed 20.15 per cent was available for production. During the last one-half year the carbohydrates consumed were not sufficient to fulfill the requirements for maintenance.

This cow was in the experiment three and one-half years, was dry 11 months, and gave birth to three calves. She was not a persistent milker, each lactation period falling short of a year.

As an economical producer she stands ninth in milk, eleventh in fat and twelfth in milk solids.

15.9 pounds milk per day during entire time.

	Protein.	Carbo.	Fat	Total.
Nutrients per pound of milk,	.11817	.6266	.03867	.8318
Called for by standard,	.1047	.8000	.02430	.9593

TABLE NO. 18.

Cow No. 5.

Lbs. Milk, Fat and Solids Produced and Nutrients Consumed.

	Milk.	% Fat.	Fat.	% Solids	Solids	Protein.	Carbo-hydrates	Fat.	N. R.
First year,	7220.10	4.05	292.69	13.1	945.83	676.61	3865.20	264.89	1:6.6
Second year,	6083.10	3.79	230.65	12.8	778.63	718.88	3772.82	213.32	1:5.9
Third year,	6333.30	3.77	238.88	12.8	810.66	737,62	3564.82	216.83	1:5.5
Fourth 1/2 yr.	713.60	3.46	24.70	12.1	86.35	271.85	1548.71	92.05	1:6.4
Total,	20350.10	3.86	786.92	12.9	2621.47	2404.96	12751.55	787.09	

Average Weight of Cow, 1335 lbs.

	Protein.	Carbo.	Fat.
Maintenance for one year,	341.09	3410.90	48.72
Consumed above Maintenance 1st year,	335.52	454.30	216.17
" " " 2nd "	377.79	361.92	164.60
" " " 3d "	396.53	153.92	168.11
" " " 4th 1/2 yr.	101.31	- 156.74	67.69
Total,	1211.15	813.40	616.57

TABLE NO. 19. Cow No. 5.

Lbs. Nutrients Consumed per Unit of Product.

Including Maintenance.

	Per 100# Milk			Per 1# Fat.			Per 100# Solids		
	Protein	Carbo.	Fat	Protein	Carbo.	Fat	Protein	Carbo.	Fat
First year,	9.370	53.527	3.668	2.311	13.205	.905	71.53	408.65	28.00
Second year,	11.817	62.021	3.506	3.116	16.357	.924	92.32	484.54	27.39
Third year.	11.646	56.286	3.423	3.087	14.923	.907	90.99	439.74	26.69
Fourth 1/2 year,	38.095	217.027	12.899	11.006	62.700	3.726	314.48	1793.50	106.60
Average, 3-1/2 years,	11.817	62.660	3.867	3.056	16.204	1.000	91.74	486.42	30.02

Excluding Maintenance.

	Per 100# Milk			Per 1# Fat.			Per 100# Solids		
	Protein	Carbo.	Fat	Protein	Carbo.	Fat	Protein	Carbo.	Fat
First year,	4.646	6.291	2.993	1.146	1.552	.738	35.47	48.03	22.85
Second year,	6.210	5.949	2.705	1.638	1.569	.713	48.52	46.47	21.14
Third year,	6.261	2.430	2.654	1.653	.644	.703	48.91	18.98	20.73
Fourth 1/2 year,	14.197	- 21.964	9.485	4.101	6.346	2.740	117.30	- 181.50	78.84
Average, 3-1/2 years,	5.951	3.997	3.029	1.539	1.033	.783	46.20	31.03	23.52

Cow 8.

The results from No. 8 are given in tables 19 and 20. This cow was also selected because of her lack of dairy qualities and proved to be a very unprofitable cow. She was a grade, evidently largely of Shorthorn blood.

After deducting maintenance, 27.52 per cent of the nutrients consumed was available for production.

While in the experiment she was dry seven months and gave birth to two calves.

In economy of production she stands tenth in milk, ninth in fat and ninth in milk solids.

13 pounds of milk per day during the entire time.

	Protein.	Carbo.	Fat	Total
Nutrients per pound of milk,	.11890	.6334	.04186	.8464
Called for by standard,	.1012	.7588	.02400	.9140

TABLE NO. 19.

Cow No. 8.

Lbs. Milk, Fat and Solids Produced and Nutrients Consumed.

	Milk.	% Fat.	Fat.	% Solids	Solids	Protein.	Carbo-hydrates	Fat.	N. R.
First year,	7542.00	4.26	321.68	13.50	1018.17	635.08	3586.00	244.94	1:6.5
Second year,	3614.40	4.13	149.35	13.20	477.10	535.36	2832.38	188.33	1:5.1
Third year,	3070.10	3.84	117.96	12.80	392.97	521.17	2600.50	162.26	1:5.6
Total,	14226.50	4.14	588.99	13.20	1887.24	1691.51	9018.88	595.53	

Average Weight of Cow, 1000 lbs.

	Protein.	Carbo.	Fat.
Maintenance for one year,	255.50	2555.00	36.50
Consumed above Maintenance 1st year,	379.58	1031.00	208.44
" " " 2nd "	279.86	277.38	151.84
" " " 3d "	265.67	45.50	125.76
Total,	925.11	1353.88	486.04

TABLE NO..20. Cow No. 8.

Lbs. Nutrients Consumed per Unit of Product.

Including Maintenance.

	Per 100# Milk			Per 1# Fat.			Per 100# Solids		
	Protein	Carbo.	Fat	Protein	Carbo.	Fat	Protein	Carbo.	Fat.
First year,	8.420	47.547	3.247	1.974	11.147	.761	62.37	352.20	24.056
Second year,	14.813	78.372	5.211	3.705	18.964	1.269	112.20	593.66	39.473
Third year,	16.975	84.704	5.285	3.489	17.411	1.086	132.62	661.75	41.290
Average, 3 years,	11.890	63.339	4.186	2.872	15.312	1.011	89.63	477.81	31.55

Excluding Maintenance.

	Per 100# Milk			Per 1# Fat.			Per 100# Solids		
	Protein	Carbo.	Fat	Protein	Carbo.	Fat	Protein	Carbo.	Fat.
First year,	5.032	13.670	3.770	1.179	3.205	.647	37.28	101.26	20.47
Second year,	7.743	7.675	4.201	1.873	1.857	1.016	58.65	58.13	31.82
Third year,	8.653	1.482	4.096	1.778	.304	.842	67.60	11.57	32.00
Average, 3 years,	6.502	9.115	3.415	1.570	2.298	.825	49.02	71.73	25.75

Cow 7.

Cow number seven was a grade cow of poor dairy form and a poor producer. She was four years in the experiment and the results are given in tables 21 and 22. She was dry twelve months and gave birth to three calves. The average length of lactation period was only nine months, showing that she was not a persistent milker.

20.54 per cent of the nutrients consumed was available for production.

In economy of production she stands eleventh in milk, tenth in fat and tenth in solids.

14.4 pounds of milk per day during the entire period.

	Protein.	Carbo.	Fat	Total
Nutrients per pound of milk,	.12318	.63176	.04125	.84875
Called for by standard,	.1025	.77400	.02410	.93070

TABLE NO. 21. Cow No. 7.

Lbs. Milk, Fat and Solids Produced and Nutrients Consumed.

	Milk.	% Fat	Fat.	% Solids	Solids	Protein.	Carbo-hydrates	Fat.	N. R.
First year,	5597.40	4.14	231.82	13.3	744.45	593.82	3440.04	229.44	1:6.6
Second year,	6072.00	4.19	254.49	13.3	807.57	663.51	3435.57	231.52	1:6.5
Third year,	5419.50	4.12	223.47	13.2	715.37	727.93	3238.74	219.25	1:5.1
Fourth year,	3894.20	3.57	139.24	12.9	502.35	620.56	3142.09	185.44	1:5.7
Total,	20983.10	4.04	849.02	13.2	2769.74	2605.82	13256.44	865.65	

Average Weight of Cow, 1150 lbs.

	Protein.	Carbo.	Fat.
Maintenance for one year,	307.82	3078.25	43.97
Consumed above Maintenance 1st yr.	286.00	361.79	185.47
" " " 2nd "	355.69	357.32	187.55
" " " 3d "	420.11	160.49	175.28
" " " 4th "	312.74	63.84	141.47
Total,	1374.54	943.44	689.77

TABLE NO. 22. Cow No. 7.

Lbs. Nutrients Consumed per Unit of Product.

Including Maintenance.

	Per 100# Milk.			Per 1# Fat.			Per 100# Solids		
	Protein.	Carbo.	Fat	Protein	Carbo.	Fat	Protein	Carbo.	Fat
First year,	10.608	61.457	4.099	2.561	14.839	.989	79.76	462.09	30.82
Second year,	10.927	56.580	3.812	2.607	13.499	.909	82.16	425.46	28.66
Third year,	13.431	59.760	4.045	3.257	14.492	.981	101.75	452.73	30.65
Fourth year,	15.935	80.686	4.761	4.456	22.566	1.332	123.53	625.47	36.91
Average, 4 years,	12.418	63.176	4.125	3.069	15.613	1.019	94.08	478.61	31.25
Excluding Maintenance.									
First year,	5.109	6.463	3.313	1.233	1.560	.800	38.41	48.59	24.91
Second year,	5.859	5.884	3.088	1.397	1.404	.736	44.04	44.24	23.22
Third year,	7.751	2.961	3.234	1.879	.718	.782	58.72	22.43	24.50
Fourth year,	8.030	1.639	3.632	1.399	.285	.633	62.25	12.70	28.16
Average, 4 years,	6.550	4.496	3.287	1.618	1.111	.812	49.62	34.06	24.90

Cow 1.

Cow number one was a grade Holstein, selected from a dairy herd as an example of a profitable cow, and her record given in tables 23 and 24 fully justify the choice. She was of good dairy form and never carried a surplus of flesh.

40.87 per cent of the nutrients which she consumed was available for production.

She was three and one-half years in the experiment. During that time she was dry eight months and gave birth to three calves.

In economy of production she stands first in milk, third in fat and first in milk solids.

29.2 pounds of milk per day for the entire time.

	Protein	Carbo.	Fat	Total
Nutrients per pound of milk,	.08229	.40471	.02619	.54585
Called for by standard,	.07120	.47900	.01899	.59290

TABLE NO. 23.

Cow No. 1.

Lbs. Milk, Fat and Solids Produced and Nutrients Consumed.

	Milk	% Fat.	Fat.	% Solids	Solids	Protein.	Carbo-hydrates	Fat.	N. R.
First year,	11382.60	3.73	425.60	12.6	1434.20	784.01	4397.77	308.70	1:6.5
Second year,	11735.10	3.60	422.19	12.4	1455.15	838.22	4219.35	299.12	1:5.8
Third year,	10505.10	3.38	355.21	12.0	1260.61	1001.88	4462.85	266.79	1:5
Fourth 1/2 yr.	3699.70	3.40	125.15	12.0	443.96	447.38	2024.96	108.08	1:5
Total,	37322.50	3.55	1328.15	12.3	4593.92	3071.49	15104.93	977.69	

Average Weight of Cow, 1190 lbs.

	Protein.	Carbo.	Fat.
Maintenance for one year,	304.04	3040.45	43.43
Consumed above Maintenance 1st year,	479.97	1357.32	265.26
" " " 2nd "	534.18	1178.90	250.69
" " " 3d "	697.84	1422.40	223.36
" " " 4th 1/2 yr.	295.36	504.74	86.37
Total,	2007.35	4463.36	825.68

TABLE NO. 24.

Cow No. 1.

Lbs. Nutrients Consumed per Unit of Product.

	Per 100# Milk			Per 1# Fat.			Per 100# Solids		
	Protein	Carbo.	Fat	Protein	Carbo.	Fat.	Protein	Carbo.	Fat
Including Maintenance.									
First year,	6.887	38.635	2.712	1.842	10.333	.725	54.66	306.63	21.52
Second year,	7.142	35.955	2.506	1.985	9.993	.696	57.60	289.95	20.21
Third year,	9.537	42.482	2.539	2.820	12.564	.751	80.81	354.02	21.16
Fourth 1/2 year,	12.092	54.733	2.921	3.574	16.180	.863	100.77	456.11	24.34
Average, 3-1/2 years,	8.229	40.471	2.619	2.312	11.373	.736	66.85	328.80	21.28
Excluding Maintenance.									
First year,	4.216	11.924	2.330	1.127	3.189	.623	33.46	94.63	18.49
Second year,	4.551	10.046	2.136	1.265	2.792	.593	36.70	81.01	17.23
Third year,	6.642	13.531	2.126	1.964	4.004	.628	55.35	112.83	17.75
Fourth 1/2 yr.	7.982	13.643	2.334	2.360	4.033	.690	66.52	113.69	19.45
Average, 3-1/2 years,	5.378	11.958	2.212	1.511	3.360	.621	43.69	97.15	17.97

Cow 2.

Cow number two was a grade, probably of Shorthorn and Holstein blood. While of the beef form, she proved to be a fairly good producer.

28.42 per cent of the nutrients consumed by this cow were available for production.

She was in the experiment three and one-half years, was dry four months and gave birth to three calves.

In economy of production she stands sixth in milk, seventh in fat and eighth in milk solids.

21 pounds of milk daily for the entire time.

	Protein.	Carbo.	Fat	Total
Nutrients per pound of milk,	.09598	.4962	.03216	.66454
Called for by standard,	.0850	.6170	.02090	.74900

TABLE NO. 24.

Cow No. 2.

Lbs. Milk, Fat and Solids Produced and Nutrients Consumed.

	Milk.	% Fat	Fat.	% Solids	Solids	Protein.	Carbo-hydrates	Fat.	N. R.
First year,	9542.50	3.45	330.07	12.1	1154.64	699.65	3946.87	266.82	1:6.4
Second "	7790.60	3.49	272.29	12.2	950.45	755.56	3892.07	264.95	1:5.9
Third "	7030.40	3.66	257.66	12.5	878.80	776.44	3668.13	221.19	1:5.3
Fourth-1/2 yr.	2450.00	3.42	83.91	12.0	294.04	342.06	1798.18	109.49	1:5.9
Total,	26813.50	3.52	943.93	12.2	3277.93	2573.71	13305.25	862.45	

Average Weight of Cow, 1258 lbs.

	Protein.	Carbo.	Fat.
Maintenance for one year,	321.40	3214.19	45.92
Consumed above Maintenance 1st year,	378.25	732.68	220.90
" " " 2nd, "	434.16	677.88	219.03
" " " 3d "	455.04	453.94	175.27
" " " 4th "	181.99	191.99	77.71
Total,	1449.44	2056.49	692.91

TABLE NO. 25.

Cow No. 2.

Lbs. Nutrients Consumed per Unit of Product.

	Per 100# Milk.			Per 1# Fat.			Per 100# Solids		
	Protein	Carbo.	Fat	Protein	Carbo.	Fat.	Protein	Carbo.	Fat.
Including Maintenance.									
First year,	7.332	41.361	2.796	2.119	11.958	.808	60.59	341.82	23.10
Second year,	9.698	49.958	3.401	2.774	14.293	.973	79.49	409.49	27.77
Third year,	11.043	52.175	3.145	3.013	14.236	.858	88.35	417.40	25.16
Fourth 1/2 yr.	13.961	73.395	4.468	4.076	21.421	1.304	116.33	611.54	37.23
Average, 3-1/2 years,	9.598	49.621	3.216	2.726	14.095	.914	78.51	405.90	26.31
Excluding Maintenance.									
First year,	3.963	7.678	2.314	1.145	2.219	.669	32.75	63.45	19.13
Second year,	5.572	8.701	2.811	1.594	2.489	.804	45.67	71.32	23.04
Third year,	6.472	6.456	2.492	1.766	1.761	.680	51.77	51.65	19.94
Fourth 1/2 year,	7.428	7.836	3.171	2.168	2.288	.926	61.89	65.29	28.42
Average, 3-1/2 years,	5.405	7.669	2.584	1.535	2.178	.734	44.21	62.73	21.13

Cow O.

The record of this cow is given in tables 26 and 27. She was a purebred Guernsey of medium size and poor dairy form, yet an economical producer. She was in the experiment but one year.

44.30 per cent of the nutrients consumed by this cow was available for production.

In economy of production she stands seventh in milk, first in fat and second in milk solids. Her milk contained an average of 5.2 per cent fat, which accounts for her high standing in the economy of fat production.

18.7 pounds of milk per day for the entire time.

	Protein.	Carbo.	Fat	Total.
Nutrients per pound of milk,	.09048	.51524	.03471	.68382
Called for by standard,	.0895	.599	.0242	.7429

TABLE NO. 26. Cow No. 0.

Lbs. Milk, Fat and Solids Produced and Nutrients Consumed.

	Milk	% Fat	Fat.	% Solids	Solids.	Protein.	Carbo-hydrates	Fat.	N. R.
One year,	6835.40	5.26	360.12	14.7	1004.80	618.52	3521.91	237.31	1:6.5

Average Weight of Cow, 900 lbs. (Est)

	Protein.	Carbo.	Fat
Maintenance for one year,	229.95	2299.50	32.85
Consumed above Maintenance,	388.57	1222.41	204.46

****

TABLE NO. 27. Cow No. 0.

Lbs. Nutrients Consumed per Unit of Product.

Including Maintenance.

	Per 100# Milk			Per 1# Fat.			Per 100# Solids		
	Protein	Carbo.	Fat	Protein	Carbo.	Fat	Protein	Carbo.	Fat
One year,	9.048	51.524	3.471	1.717	9.779	.658	61.55	350.50	23.61
Excluding Maintenance.									
One year,	5.684	17.883	2.991	1.079	3.394	.567	38.67	121.65	20.34

Cow 45.

In tables 28 and 29 is given the results of a year's record of cow 45. She was a pure-bred Guernsey of good size and of good dairy form.

One point of interest in connection with this record is that more nutrients were consumed above maintenance than by any other cow. 55.39 per cent of these nutrients was available for production. She did not use it most economically, however.

In economy of production she stands fifth in milk, second in fat and fifth in milk solids.

21.6 pounds milk daily during the entire time.

	Protein.	Carbo.	Fat	Total
Nutrients per pound of milk,	.10212	.54064	.03049	.71136
Called for by standard,	.0840	.565	.0225	.7106

TABLE NO.. 28.

Cow No. 45.

Lbs. Milk, Fat and Solids Produced and Nutrients Consumed.

	Milk.	% Fat	Fat.	% Solids	Solids.	Protein.	Carbo-hydrates	Fat.	N. R.
One year,	7883.70	4.72	372.44	14.0	1103.71	805.10	4260.32	240.38	1:5.2

Average Weight of Cow, 1000 lbs. (Est)

	Protein.	Carbo.	Fat
Maintenance for one year,	255.50	2555.00	36.50
Consumed above Maintenance,	549.60	1705.32	203.88

****

TABLE NO. 29.

Cow No. 45.

Lbs. Nutrients Consumed per Unit of Product.

Including Maintenance.

	Per 100# Milk.			Per 1# Fat.			Per 100# Solids		
	Protein.	Carbo.	Fat	Protein	Carbo.	Fat.	Protein	Carbo.	Fat
One year,	10.212	54.064	3.049	2.161	11.438	.645	72.94	385.99	21.77

Excluding Maintenance.

One year,	6.971	21.630	2.586	1.475	4.578	.547	49.79	154.50	18.47

Cow 36.

This cow was a pure-bred Holstein about three years old, of good producing ancestry and of good dairy form. She stands second in the amount of nutrients consumed above maintenance, 49.46 per cent being available for production.

In economy of production this cow stands third in milk, fifth in fat and fourth in milk solids.

28.4 pounds per day for the entire time.

	Protein	Carbo.	Fat	Total
Nutrients per pound of milk,	.0886	.4407	.0231	.5813
Called for by standard,	.0743	.520	.0188	.6286

TABLE NO. 30.

Cow No. 36.

Lbs. Milk, Fat and Solids Produced and Nutrients Consumed.

	Milk	% Fat	Fat.	% Solids	Solids.	Protein.	Carbo-hydrates	Fat.	N. R.
One year,	10360.10	3.24	335.51	11.5	1191.41	918.10	4565.75	239.34	1:5.5

Average Weight of Cow, 1350 lbs. (Est.)

	Protein.	Carbo.	Fat.
Maintenance for one year,	344.92	3449.25	49.27
Consumed above Maintenance,	573.18	1116.50	190.07

****

TABLE NO. 31.

Cow No. 36.

Lbs. Nutrients Consumed per Unit of Product.

	Per 100# Milk			Per 1# Fat.			Per 100# Solids		
	Protein	Carbo.	Fat	Protein	Carbo.	Fat.	Protein	Carbo.	Fat
Including Maintenance.									
One year,	8.861	44.070	2.310	2.736	13.608	.713	77.05	383.22	20.08
Excluding Maintenance.									
One year,	5.532	10.77	1.840	1.708	3.327	.566	48.109	93.71	15.95

The preceding tables are summarized in tables 32 and 33. These tables bring together the averages from each cow for comparison.

A careful study will show that the largest producers of milk are not always the most economical producers of fat, nor is the most economical producer of milk or fat necessarily the most economical producer of milk solids.

In comparing these two tables we find some rather surprising results. The cow (No. 3) which consumed the smallest amount of nutrients above maintenance appears to have used the smallest amount of net nutrients per unit of product. This can be at least partly explained by repeating what was said earlier,--that the coefficients of digestible nutrients, used in the case of some of the foods, were undoubtedly too low. This would work to the advantage of the cow consuming the smallest margins above maintenance and also producing a small amount of milk.

The relative standing of the individual cows in amount of nutrients consumed per unit of product, both including and excluding maintenance, is shown in table 34. Table 35 is a final summary of the results from the 13 cows and a comparison of these results, as far as practical, with Haecker's standard.

The results from the individual cows are divided into groups for this comparison.

The averages from the cows giving milk containing the same percentage of fat, are grouped together and this average compared with the standard.

Invariably the amount of protein and fat consumed is greater than called for by the standard. Invariably the amount of carbohydrates is lower. Multiplying the fat by 2-1/4 and adding to the product the protein and carbohydrates, placing them on the same energy basis, we find that all of the groups required a little less total nutrients than called for by the standard.

TABLE NO. 32.

Average Nutrients Consumed per Unit of Product by Different Cows.

Including Maintenance.

	Per 100 lbs. Milk				Per 1 lb. Fat.				Per 100 lbs. Solids			
	Proteim	Carbo.	Fat	Total.	Protein	Carbo.	Fat	Total.	Protein	Carbo.	Fat	Total
Cow 19	14.718	75.851	4.830	91.656	4.370	22.525	1.433	30.119	123.22	635.02	46.44	872.730
" 17	8.692	41.784	2.690	56.528	2.835	13.631	.877	18.439	76.71	368.72	23.74	498.845
" 18	8.430	44.520	2.960	59.610	2.721	14.366	.957	19.240	74.69	394.31	26.28	528.130
" 20	12.419	57.669	3.666	78.336	2.495	11.587	.736	15.736	86.39	401.18	25.50	544.945
" 3	12.924	69.115	4.508	92.182	3.638	19.461	1.269	25.954	104.56	559.47	36.58	746.330
" 5	11.817	62.660	3.867	83.177	3.056	16.204	1.000	21.510	91.74	486.42	30.02	645.705
" 8	11.890	63.339	4.186	84.647	2.872	15.312	1.011	20.458	89.63	477.81	31.55	638.427
" 7	12.418	63.176	4.125	84.875	3.069	15.613	1.019	20.974	94.08	478.61	31.25	643.002
" 1	8.229	40.471	2.619	54.592	2.312	11.373	.736	15.341	66.85	328.80	21.28	443.530
" 2	9.598	49.621	3.216	66.455	2.726	14.095	.914	18.877	78.51	405.90	26.31	626.647
" 0	9.048	51.524	3.471	68.381	1.717	9.779	.658	12.976	61.55	350.50	23.61	465.172
" 45	10.212	45.064	3.049	62.136	2.161	11.438	.645	15.050	72.94	385.99	21.77	507.912
" 36	8.861	44.070	2.310	58.128	2.736	13.608	.713	17.948	77.05	383.22	20.08	505.450

TABLE NO. 33.

Average Nutrients Consumed per Unit of Product by Different Cows.

Excluding Maintenance.

	Per 100 lbs. Milk				Per 1 lb. Fat.				Per 100 lbs. Solids			
	Protein	Carbo.	Fat	Total.	Protein	Carbo.	Fat	Total	Protein	Carbo.	Fat	Total
Cow 19	7.304	.047	3.780	15.856	2.168	.001	1.123	4.696	61.15	.39	31.66	132.775
" 17	5.579	10.620	2.245	21.250	1.820	3.465	.732	6.932	49.24	93.72	19.81	187.532
" 18	4.920	9.110	2.460	19.565	1.587	3.033	.794	6.406	43.57	83.24	21.79	175.837
" 20	8.889	22.371	3.159	38.367	1.786	4.494	.634	7.706	61.84	155.62	21.97	222.403
" 3	5.318	- 6.937	3.534	6.332	1.497	-2.360	.995	1.376	43.03	- 56.14	28.60	51.240
" 5	5.951	3.997	3.029	16.763	1.539	1.033	.783	4.334	46.20	31.03	23.52	130.150
" 8	6.502	9.115	3.415	23.300	1.570	2.298	.825	5.724	49.02	71.73	25.75	178.687
" 7	6.550	4.496	3.287	18.441	1.618	1.111	.812	4.556	49.62	34.06	24.90	139.705
" 1	5.378	11.958	2.212	22.313	1.511	3.360	.621	6.266	34.69	97.15	17.97	172.272
" 2	5.405	7.669	2.584	18.888	1.535	2.178	.734	5.364	44.21	62.73	21.13	154.482
" 0	5.684	17.883	2.991	30.296	1.079	3.394	.567	5.748	38.67	121.65	20.34	206.085
" 45	6.971	21.630	2.586	34.419	1.475	4.578	.547	7.283	49.79	154.50	18.47	245.847
" 36	5.532	10.770	1.840	28.749	1.708	3.327	.566	6.308	48.11	93.71	15.95	177.706

TABLE NO. 34.

The Percent of Digestible Nutrients Consumed, Which is Used by the Animal for Product, and the Relative Standing of the Different Cows in Economy of Production of Milk, Milk Fat and Total Milk Solids.

Including Maintenance.

	Per cent Used.	Standing in Milk.	Standing in Fat.	Standing in Milk Solids
Cow No. 19	17.29	12th	13th	13th
" " 17	39.53	2nd	6th	3d
" " 18	32.82	4th	8th	6th
" " 20	48.99	8th	4th	7th
" " 3	5.29	13th	12th	12th
" " 5	20.15	9th	11th	11th
" " 8	27.52	10th	9th	9th
" " 7	20.54	11th	10th	10th
" " 1	40.87	1st	3d	1st
" " 2	28.42	6th	7th	8th
" " 0	44.30	7th	1st	2nd
" " 45	55.39	5th	2nd	5th
" " 36	49.46	3d	5th	4th

Excluding Maintenance.

Cow No. 19	2nd	4th	3d
" " 17	7th	11th	10th
" " 18	6th	10th	7th
" " 20	13th	13th	13th
" " 3	1st	1st	1st
" " 5	3d	2nd	2nd
" " 8	9th	6th	9th
" " 7	4th	3d	4th
" " 1	8th	8th	6th
" " 2	5th	5th	5th
" " 0	11th	7th	11th
" " 45	12th	12th	12th
" " 36	10th	9th	8th

TABLE NO. 35.

Nutrients Consumed per Pound of Milk Containing Different Percents Fat, Compared with Haecker's Standard.

	Protein	Carbo.	Fat	Total
Milk Testing 3% Fat. (2 cows).				
Our finding,	.0861	.4259	.0277	.5689
Haecker's standard,	.0793	.5770	.0193	.6997
Nutrients consumed less than standard, 18.3 per cent.				
Milk Testing 3.3% Fat. (2 cows).				
Our finding,	.1258	.6427	.03912	.8565
Haecker's standard,	.1012	.786	.0229	.93879
Nutrients consumed less than standard, 8.7 per cent.				
Milk Testing 3.5% Fat. (3 cows).				
Our finding,	.0965	.5208	.0322	.6897
Haecker's standard,	.0863	.6300	.02105	.76366
Nutrients consumed less than standard, 10.9 per cent.				
Milk Testing 4% Fat. (3 cows).				
Our finding,	.1206	.6304	.0404	.8419
Haecker's standard,	.1019	.768	.024	.9239
Nutrients consumed less than standard, 8.8 per cent.				
Milk Testing 5% Fat. (3 cows).				
Our finding,	.1115	.5545	.0347	.7441
Haecker's standard,	.0896	.610	.0237	.7530
Nutrients consumed less than standard, 1.2 per cent.				
Final Average, (3.7% Fat.)				
Our finding,	.1059	.5775	.0345	.7609
Haecker's standard,	.0906	.6661	.0219	.8060
Nutrients consumed less than standard, 5.5 per cent.				

In the final average at the bottom of table 35 our finding shows a consumption of .08356 of a pound of nutrients per pound of milk, less than called for by the standard. This is 5.5 per cent below the standard, which is certainly a very close agreement. Had a careful analysis of the foods been available, the difference would probably have been less. It must also be remembered that the period covered by this experiment covers the entire lactation period and also many dry periods during which more than a maintenance ration was fed.

For further comparison the summaries from two other feeding experiments are here given in tables 36 and 37. Table 36 gives the results from two lots of cows of nine each. Lot I. was fed a moderately good, well balanced ration. (N. R. 1:6.6). Lot II. was fed a less palatable ration, poorly balance. (N. R. 1:11). Both of these lots were given as much of the food as they cared to consume, but the ratio was kept practically the same. The experiment continued nearly nineteen weeks, during the best part of the lactation period. The two lots were very well balanced in production.

TABLE NO. 36.

Nutrients Consumed per Pound of Product.

LOT I.

	Protein	Carbo.	Fat	Total
Per pound of solids,	.5725	3.040	.2539	4.194
" " " fat,	2.0800	11.074	.9250	15.335
" " " milk,	.0668	.3269	.02964	.4604
Called for by standard,	.0626	.4030	.0176	.5052

Amount consumed less than called for by standard,-- 8.8 per cent.

LOT II.

	Protein	Carbo.	Fat	Total.
Per pound of solids,	.4756	4.373	.2473	5.4058
" " " fat,	1.623	15.528	1.0780	19.5760
" " " milk,	.0542	.4808	.02934	.6010
Called for by standard,	.0756	.5297	.01922	.6485

Amount consumed less than called for by standard,-- 7.5 per cent.

This table shows that the lot getting the "wide ration" consumed 28.8 per cent more nutrients per pound of solids and 30.5 per cent more per pound of milk than the lot getting the well balanced ration. It should be noted that a part of this difference in nutrients per pound of milk is due to the fact that the milk from Lot II. contained a higher per cent of solids.

The lot getting the "wide ration" lost materially in weight during the experiment. This was so marked that the question of terminating the experiment at the end of the twelfth week was seriously considered, while the lot receiving the balanced ration maintained their weight.

Theoretically, Lot II. should have produced milk more economically because of the great loss in weight, but of total nutrients they required 29 per cent more. This difference is due to the lack of a proper supply of protein and palatability in the ration.

Table 37 gives the results obtained from feeding eleven cows for one year. The ration was palatable, well balanced, and very liberally supplied. Their ration consisted of alfalfa hay, corn silage, corn meal and bran. They were fresh at or near the beginning of the year. Some were very good producers and others very poor producers. During the year they made an average body gain of about 165 pounds.

TABLE NO. 37.

	Protein	Carbo.	Fat	Total
Consumed per pound of milk,	.1268	.6140	.0808	.9148
Haecker's standard,	.0801	.5606	.0210	.6289

Consumed more than called for by standard, 45.4 per cent.

This table shows that much more was consumed than called for by the standard.. If, however, we deduct the amount necessary to produce an average gain of 165 pounds, the total consumed per pound of milk will approach more closely the standard.

Bringing together our findings, we have the following:

TABLE NO. 38.

	Protein	Carbo.	Fat	Total
	MILK			
Average, 33 lactation periods,	.1034	.5037	.0333	.6674
" 35 yearly records,	,1059	.5775	.0345	.7610
" 9 cows, 19 weeks' narrow ration,	.0668	..3269	.02964	.4604
" 9 cows, 19 weeks' wide ration,	.0542	.4808	.02934	.6010
" 11 yearly records, heavy feeding,	.1268	.6140	.08080	.9148
	FAT.			
Average, 33 lactation periods,	2.59	13.31	.835	16.735
" 35 yearly records,	2.823	14.537	.9206	19.432
" 9 cows, 19 weeks! narrow ration,	2.08	11.074	.925	15.335
" 9 cows, 19 weeks' wide ration,	1.623	15.528	1.078	19.576
" 11 yearly records, heavy feeding,	.3445	13.119	2.165	21.435
	SOLIDS.			
Average, 33 lactation periods,	.78	4.01	.253	5.043
" 35 yearly records,	.839	4.199	.2780	5.6635
" 9 cows, 19 weeks' narrow ration,	.5725	3.04	.2539	4.194
" 9 cows, 19 weeks' wide ration,	.4756	4.373	.2473	5.4058
" 11 yearly records, heavy feeding,	1.018	4.931	.648	7.407

These results, based on solids, are quite uniform when we consider the different conditions under which the different groups were fed, and the

differences are in logical order: The group fed a well balanced ration for a short period of the early part of the lactation period gave lowest requirements; the group for full lactation period on good ration gave second lowest results; the group fed on a "wide ration" for a short period of time during the early part of the lactation period stands third in results; the group fed for the long period, covering in some cases four years, gave next to highest results; and the group fed very heavily on a good ration gained materially in weight and gave the highest, or least economical results.

The net nutrients per unit of product have not been carried out, though it would show more interesting facts. Some of the cows which require a large amount per unit of product , including maintenance, appear to require the least amount of net nutrients. By net nutrients is meant the amount above that required for maintenance and gain.

Professor Haecker has said that the net nutrients required by dairy cows is practically the same in all cows. This does not appear to be borne out fully in these results, though they indicate a smaller difference than is commonly believed. The cows with which Professor Haecker did his work were a very uniform lot and of much the same breeding.

CONCLUSIONS.

1. There is a great variation in the amount of nutrients required per unit of product from the early to the latter part of the lactation period.

2. The results here found seem to indicate that Haecker's standard calls for a liberal amount of nutrients.

3. Either under feeding or over feeding tends to increase the requirements per unit of product. There is a "happy medium" which gives best results per unit of nutrients consumed.

4. In most cases the heaviest producers are the most economical producers.

5. The highest producers seem to require more net nutrients per unit of product than the lighter producers.

6. Approximately five and ene-half pounds of digestible nutrients are required to produce a pound of milk solids, including maintenance.

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